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POLICY AND LEGAL ISSUES INVOLVED IN THE COMMERCIALIZATION OF SPACE

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HON. BOB PACKWOOD, *Chairman*

FOR THE USE OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION
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LETTER OF TRANSMITTAL

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, D.C., September 23, 1983.

DEAR COLLEAGUE:

The Committee on Commerce, Science, and Transportation and the Subcommittee on Science, Technology, and Space are pleased to submit this report on the policy and legal issues associated with the commercialization of space. Information in this report was originally requested of the Congressional Research Service by Senator Hollings.

This report is particularly timely given the decision by the President in March 1983, to pursue the transfer of the weather and land remote sensing satellites to the private sector and his May, 1983, announcement that the Government will facilitate commercial operation of Expendable Launch Vehicles.

The Committee and the Congress have approved legislation which would require Congressional participation in the implementation of any plan to commercialize these national assets. It is not the purpose of the legislation or the intent of the Committee to foreclose the options for commercialization; rather, there is a legitimate Congressional interest in the proposals such as to require timely and open participation in the decision process.

The commercial promise of space is being realized. Our first revolution is in communications; the next could be in materials processing or terrestrial observations, as examples. Government has led and continues to lead the research and development, but commercialization is primarily a private sector responsibility. We have not yet determined when, how or what governmental responsibility should be relinquished so that the public benefit will be optimized.

The report which we are releasing sheds additional light on the problems and issues of commercializing space activities. The effective resolution of these issues will be of major importance to our national security and economic well-being.

Cordially,

BOB PACKWOOD,
Chairman, Committee on Commerce, Science, and Transportation.

SLADE GORTON,
Chairman, Subcommittee on Science, Technology, and Space.

LETTER OF SUBMITTAL

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, D.C., July 20, 1983.

Hon. BOB PACKWOOD,
Chairman, Committee on Commerce, Science, and Transportation, U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: I am pleased to transmit a report by the Congressional Research Service, prepared at my request, evaluating the legal and policy issues involved in space commercialization.

One of the significant areas of continued U.S. international leadership is space. With the successful operation of the Space Shuttle, we now have a capability to utilize space on a routine basis. This will help lead the way to enormous economic and commercial benefits. As a Nation we must be prepared to pursue the opportunities in such areas as launch services, communications, remote sensing and materials processing.

In entering this new commercial era of space, we are likely to encounter various policy and legal questions. This CRS report should help the Congress and others indentify those questions and various options to deal with them. I hope this report will be made available widely.

With kindest regards, I am

Sincerely,

ERNEST F. HOLLINGS, *Ranking Democrat.*

Enclosure.

CONGRESSIONAL RESEARCH SERVICE,
THE LIBRARY OF CONGRESS,
Washington, D.C., May 12, 1983.

Hon. ERNEST F. HOLLINGS,
U.S. Senate,
Washington, D.C.

DEAR SENATOR HOLLINGS: Pursuant to your letter of January 17, 1983, we are herewith providing a study entitled "Policy and Legal Issues Involved in the Commercialization of Space." The report was prepared by Marcia S. Smith, Specialist in Aerospace and Telecommunications Systems of the Science Policy Research Division, and Daniel Hill Zafren, Specialist in American Public Law of the American Law Division.

We hope that this study will be useful to you in assessing the implications of space commercialization activities in your role as ranking minority member of the Committee on Commerce, Science, and Transportation.

If we can be of further assistance, please let us know. With best regards,

Sincerely,

GILBERT GUDE, *Director.*

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SUMMARY

In 1982, President Reagan announced that it is U.S. policy to "expand U.S. private-sector investment and involvement in civil space and space related activities." To accomplish this goal, the administration must be prepared to consider alternatives such as providing Government subsidies to encourage commercialization and giving the National Aeronautics and Space Administration (NASA) additional funding and direction to organize itself for assisting in the commercialization process. The latter is particularly important in the areas of educating and communicating to industry what opportunities already exist, and performing research and development necessary for creating a basis on which companies can decide to enter the space business.

The legal and policy issues involved in this developing area are many, and while some have been discussed in the past, the recent surge in proposals from private companies has spurred a new urgency for their consideration and expeditious resolution. Among the issues discussed in this report are:

— The need for NASA to better organize itself for its role in commercial space endeavors in terms of centralizing responsibility, clarifying the types of agreements that are needed/desired with the private sector, and communicating with the private sector;

— The dilemma NASA faces in trying to encourage private sector interest in space endeavors, such as the commercialization of expendable launch vehicles, while protecting its own interests;

— The possible interpretation of the National Aeronautics and Space Act that all private sector space activities must be carried out under NASA's aegis;

— The need for coordination among the various Federal agencies with responsibilities in commercial space ventures, with the potential of designating a lead agency, and between the Federal Government and State and local governments.

— The choices which must be made by the Government between the desire to commercialize space and the potential cost of subsidizing such ventures, and maintaining competitiveness with other countries at the same time;

— The proper role of the Government vis-a-vis the private sector in performing advanced research and development on "commercial" systems;

— The need to regulate private sector space activities, both for safety and for conformance with international treaty obligations;

— The impact of national security requirements on commercialization proposals;

— The need to clarify responsibilities, obligations, funding, contributions, and claims procedures for liability associated with space ventures; and

— The need to reassess patent law to encourage commercialization.

The President's policy is to expand private sector involvement in space, but such activity is not without financial risks to the Government, not only if subsidies are required, but if a commercial venture fails and the Government must buy back into the system. Thus the first important step is to decide if commercialization is worth that risk. If the answer is yes, then the resolution of the other issues can follow.

PART I: POLICY ISSUES INVOLVED IN THE COMMERCIALIZATION OF SPACE

Prepared by Marcia S. Smith, Specialist in Aerospace and Telecommunications Systems, Science Policy Research Division, Congressional Research Service.

INTRODUCTION

Once solely the province of Government-funded research and development, space technology has become an area of increasing involvement by the private sector, not only in terms of R&D, but also in commercial applications.

For many years, NASA has fostered the transfer of space technology to the private sector through technology transfer and utilization programs such as COSMIC (a computerized program for making available to anyone research accomplished at NASA), yielding "spinoff" benefits such as rechargeable pacemakers for the heart. These secondary applications of NASA technology have been extensively detailed in many publications (such as NASA's annual spinoff books).

Recently, however, the private sector has begun showing interest not just in these applications of space-derived technology, but in becoming part of the space business itself. Several companies are actively pursuing the possibility of marketing expendable launch vehicles once NASA phases out their use in favor of the Space Shuttle, while others are involved in cooperative endeavors with NASA to develop processes and hardware for manufacturing materials in space. Companies have also come forward with plans to build space facilities such as a space station in cooperation with NASA. Other private sector activities would involve the takeover of operations of systems which have successfully completed the R&D stage. As with communications satellites, there is now a possibility of the private sector operating land remote sensing and weather satellites, as well as the Space Shuttle once it is fully operational. A summary of space commercialization proposals appears in the appendix.

As this "commercialization" of space takes root, a number of policy issues will have to be addressed. These include: The proper role of the Federal Government versus the private sector in research and development programs, and how to determine when the R&D is completed and a system is operational (and therefore ready for the private sector); how much (if any) of a subsidy should be provided by the Government to assist in commercial opportunities; methods for the Government to encourage space commercialization without creating harmful competition to itself (in providing launch services, for example); how to keep the United States competitive with foreign space ventures; what regulations (if any) are required for commercial activities in space and what agency should be in charge of these regulations; and what the national security implications of commercial activities may be.

NASA is currently developing policy guidelines for the commercialization of space and has contracted for two studies (by the National Academy of Public Administration and the Denver Research Institute) in addition to its in-house studies. Policies are expected to be announced during 1983.

This part of the study identifies policy issues which might be involved in certain areas of space commercialization, including remote sensing, expendable launch vehicles, the Space Shuttle, and materials processing in space. Legal issues are discussed in part II of this report.

Communications Satellites—A Case Example

In looking for precedents of where a space activity has successfully been turned into a commercial enterprise, the only example at this time is communications satellites. Only two other fields of space activity have reached what can be considered an "operational" status—weather satellites, and land remote sensing satellites—and both of these are still operated by the Government, although not by NASA.

Considering that the first U.S. communications satellite, Echo, was launched only in 1960, it is remarkable that the potential of this type of endeavor was recognized so quickly and turned into a commercial endeavor. It took less than 2 years from the October 12, 1960 announcement by NASA that it would launch and evaluate private communications satellites to the enactment of the Communications Satellite Act on August 31, 1962. [1]

The intense interest of the private sector in creating a commercial communication satellite system was evidenced by AT&T's application to the Federal Communications Commission (FCC) for authority to do just that on October 21, 1960, barely 2 weeks after the NASA announcement. On January 19, 1961, FCC granted AT&T the authority to establish an experimental transatlantic satellite link. On February 26, 1961, NASA and FCC released a memorandum of understanding in which FCC was identified as having the policymaking role in this area. [2]

FCC issued a notice of inquiry (NOI) on March 29, 1961 to receive views regarding the administrative and regulatory structure of a commercial communications satellite system. Seven proposals were received in response to the NOI, as well as a filing from the Justice Department outlining several antitrust considerations it wanted taken into account: The need for joint ownership by all carriers, for nondiscriminatory access to the facilities, to permit ownership by any interested equipment suppliers, and to assure competitive procurement of equipment.

Following a May report based on the responses to the NOI in which it essentially proposed that satellites be treated similarly to

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[1] Some of the information in this section is condensed from part of a study by the Science Policy Research Division of the Congressional Research Service prepared for the House Committee on Science and Technology entitled "U.S. Civilian Space Programs Volume II—Applications Satellites," which is in press.

[2] Memorandum of Understanding Between FCC and NASA On Respective Civil Communications Activities. Feb. 28, 1961. Published in U.S. Congress. House Committee on Interstate and Foreign Commerce. Communications Satellites. Pt I. 87th Cong. 1st sess. Washington, U.S. Government Printing Office. 1961. pp. 6-7.

undersea cables (as facilities jointly owned by their users), the FCC sponsored an industry conference at which it was agreed to create a committee to formulate the terms, conditions, and operational structure of the system. The committee was composed exclusively of common carriers.

Concerned about the FCC proceedings, President Kennedy wrote to Vice President Johnson on June 15, 1961 and directed him to conduct a study on how, and under what structure, to establish an operational system at "the earliest practical time." [3] Much of the work was performed by the National Aeronautics and Space Council (NASC) in consultation with industry and Government agencies. The NASC report was delivered to the President on July 16, 1961 and recommended private ownership of the U.S. portion of an international communication satellite system, coupled with Government controls to prevent monopolization.

On July 24, 1961, President Kennedy issued a communication satellite policy based on the NASC recommendations, calling for nondiscriminatory access to the system, competitive bidding in the acquisition of equipment, and foreign participation through ownership. [4]

During this time, congressional hearings had begun on the proposal. Held in June, July, and August 1961, they focussed on concerns about potential AT&T monopolization of the system. In October 1961, the FCC-established committee of common carriers issued its report, recommending a nonprofit corporation owned by AT&T and the international record carriers, with the system itself being run by the corporation but each carrier owning its own ground stations.

By the time legislation was introduced in early 1962, arguments over how to approach this issue had coalesced into basically three types of reasoning. One group argued that since the technology had been developed at Government expense, and that one of the goals was to demonstrate U.S. capabilities and good will, then the Government should own and operate the system. Another faction insisted that private companies would be more effective, as evidenced by the fact that, in their view, the United States had the best and cheapest communications system in the world. The third line of reasoning was that although the private sector might be more efficient, there was the danger of monopolization by existing private firms so a new approach was needed—a public corporation.

Three bills were introduced: One at the request of the administration creating a profitmaking, quasi-public corporation with limited ownership interest by the international common carriers, but with real control vested in voting stock controlled by the public; a second by Senator Kerr, chairman of the Aeronautical and Space Sciences Committee, creating a satellite communications corporation owned and operated exclusively by the international carriers; and a third by Senator Kefauver providing for Government ownership of the system.

After extensive congressional hearings (including 9 days by Kefauver's Subcommittee on Antitrust and Monopoly in the Senate

[3] New York Times, June 25, 1961, p. 35.
[4] Department of State Bulletin, Aug. 14, 1961, p. 273.

Judiciary Committee, even though no legislation concerning the issue had been referred there), a filibuster on the Senate floor and an historic cloture motion, the 1962 Communications Satellite Act was passed by the Senate on August 17 and the House on August 27, 1962. The President signed the legislation into law on August 31 (Public Law 87-624).

The 1962 act led to the creation of the Communications Satellite Corporation—Comsat—in 1963. As codified in the act, Comsat would be a private corporation in order to use the profit motive to spur development, would have a broad international charter to enable a global system to evolve, including those services which might not immediately show a profit, and would be organized and operated to preclude domination by a single company through ownership or patent control by having 50 percent of the stock owned by the public, and the other 50 percent by the international carriers.

In essence, Comsat was formed as a publicly owned company with Presidential supervision in the foreign policy area. FCC was directed to ensure effective competition in the purchase of telecommunications goods and services by Comsat, and to regulate the allocation of facilities by Comsat to the satellite system users. In addition, Comsat was required to provide Congress and the President with an annual report of its activities, operations, and accomplishments, and it was to be a "carrier's carrier," meaning that it could not offer services directly to users. The act authorized Comsat to provide goods and services associated with communications services and was initially interpreted as restricting Comsat to that role.

When it passed the International Maritime Satellite Telecommunications Act in 1978, which made Comsat the U.S. signatory to Inmarsat as well as Intelsat, Congress included language directing the FCC to determine whether changes were required in Comsat's structure or operations to ensure that it could fulfill its obligations under the 1962 act. The study, released in 1980, [5] addressed a number of issues, including whether Comsat should remain a carrier's carrier and whether Comsat was prohibited from entering fields other than those related to communications satellites. As noted above, the 1962 act expressly authorizes Comsat to offer communication services, but does not specifically preclude it from entering other areas.

The FCC study concluded that Comsat should be released from its carrier's carrier restriction and that it could provide services directly to end users. Also, the study concluded that Comsat could engage in any activities which are not inconsistent with its statutory mission providing that there is no cross-subsidization between Comsat's regulated services and new competitive services it might begin. An August 1982 FCC memorandum opinion and order issued after comments had been received on the 1980 study reaffirmed this position. [6] This allows Comsat the flexibility to enter other areas, such as the commercialization of remote sensing satellites in which the company has already expressed an interest.

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[5] Final Report and Order (Comsat Study), FCC 80-218, Apr. 22, 1980.

[6] Changes in the Corporate Structure and Operations of the Communications Satellite Corporation. CC Docket No, 80634; FCC 82-372. Released Aug. 13, 1982. Federal Register, vol. 47, no. 181, Sept. 17, 1982. pp. 41116-41135.

The example of how communications satellites became a commercial success is not necessarily directly relevant to today's efforts at space commercialization in other areas, however. First, there was a clear market for the communications services which Comsat was created to provide, something which is not evident today in enterprises such as materials processing in space or remote sensing. Second, a major motive for enacting the legislation was to create an international system, while today's debate concerns U.S. domestic businesses (which might serve the international market, but are not specifically designed for that purpose).

Provisions of the act which may be relevant to the current debate, however, include language such as section 102 which states that it was Congress' intent that "all authorized users shall have nondiscriminatory access to the system," and that Comsat be "organized and operated as to maintain and strengthen competition in the provision of communications services to the public." These principles might well be incorporated into commercial satellite systems for purposes other than communications.

Selected Areas for Study

For the purposes of this report, four areas have been selected for examination: remote sensing satellites, expendable launch vehicles, materials processing in space, and the Space Shuttle. Each is a current topic of discussion in terms of commercial opportunities in space and each presents unique as well as complementary policy issues.

REMOTE SENSING SATELLITES

NASA has developed three types of satellites for remote sensing of the Earth from space: Landsat and Seasat whose names are self-explanatory, and weather satellites which are designated NOAA for the National Oceanic and Atmospheric Administration which operates them along with Landsat. Only one satellite was launched in the Seasat program, and it failed after 100 days in orbit; Government proposals for launching future satellites have been indefinitely postponed.

The land and weather satellites are at the center of a debate on how best to commercialize satellite systems. Although there continues to be controversy over the precise meaning of NASA's charter, there is general agreement that NASA's prime mission (if not its only mission) is research and development (R&D) rather than operations. Thus, when the weather satellites reached an operational status, they were transferred to the Environmental Satellite Services Agency (ESSA) in the Department of Commerce, which later became part of NOAA. NASA retained responsibility for weather satellite R&D and launched several more experimental satellites after control of the operational segment was transferred to Commerce.

When it was determined that the Landsat program could also be declared operational, President Carter decided to give that system to NOAA as well. [7] His plan envisioned eventual transfer to the

[7] Presidential Directive 54, November 1979.

private sector over the course of a decade. Early in 1981, the Reagan administration indicated that it wanted to speed up that transfer timetable. This was the first step in a growing controversy which was greatly broadened when Comsat suggested that weather satellites be included in any transfer arrangement to the private sector.

In response to the Comsat suggestion, President Reagan directed the Cabinet Council on Commerce and Trade (CCCT) to study the feasibility of transferring Landsat and the weather satellites to the private sector. After an initital decision in April 1982 that the weather satellites should remain in the Government, the CCCT was asked to reassess the matter and subsequently recommended full commercialization of land, weather, and ocean satellites. As part of the CCCT reassessment, the Department of Commerce issued a request for information (RFI) from the private sector on whether and how to commercialize Landsat and/or the weather satellites. Only Comsat recommended full commercialization of both the land and weather satellites, and indicated that it was also interested in any future ocean satellites. Other companies indicated interest in parts of the Landsat and weather satellite ground segments, but not in the satellites themselves, and generally concluded that the full transfer of Landsat should take place over a period of time. One company, American Science and Technology (AS&T), expressed interest in the Landsat command and control segment, but expressed a preference for launching its own, privately developed land remote sensing satellites. AS&T sees a need for specialized remote sensing services (such as for oil companies searching for telltale geological formations which indicate oil deposits) and it plans to launch three small satellites using a privately developed launch vehicle called Conestoga. Space Services, Inc., developer of the Conestoga, is a majority shareholder in AS&T.

The major problem in commercializing Landsat is the lack of an identifiable market for the data products which would assure a company of making a profit. Comsat's solution to this problem was the suggestion of including weather satellites in the deal, since the Government itself would buy 95 percent of the data. The Comsat response to the RFI included possible terms that it would make in an offer for the land and weather satellites: Payment of $250 to $350 million for existing satellites and ground equipment, plus a guaranteed Government purchase of approximately $300 million of data every year for 15 years. The latter condition could be considered a Government subsidy, and it has also been pointed out that Comsat could get a significant tax break by investing in the new system.

The problems involved in the transfer of remote sensing satellites to the private sector have been extensively discussed in many sets of congressional hearings since 1973 (the year after the first Landsat was launched) and reports. [8] They need not be restated here, since the main purpose of including remote sensing in this discussion is to assess the current problem with commercializing

[8] See for example: Landsat—Earth Resources Satellite System, CRS Issue Brief 82066, and Commercialization of Landsat and the Weather Satellites, CRS Issue Brief 83072.

satellites in comparison with the case example of communications satellites discussed previously.

First, one clear difference is that communications satellites had a developed market for their services and Landsat does not. This has led to the question of how much, if any, subsidy should be provided in order to increase the commercial attractiveness of the system. Also, without a clear profitmaking market, there is always the possibility that the private entity would terminate its involvement if the program lost money, raising the question of how much it would cost the Government to buy back into the system.

The issue of commercializing Landsat has been complicated by Comsat's suggestion to include the weather satellites. Although it has its own meteorological satellites, the Department of Defense (DOD) uses the NOAA weather satellites on occasion, thus raising national security issues if the weather satellites are operated by the private sector. A transfer of Landsat to the private sector also presents national security issues, but these might have been dealt with more readily without added concerns about weather satellites.

The concern of the public was raised by the announcement to transfer weather satellites to the private sector, both in terms of whether they would still be able to see satellite maps on their local news programs, and in terms of services which are provided by the Government based on the weather data, such as frost forecasts. Unfortunately, at about the same time as the Government announced the transfer of the weather satellites, other changes in the Weather Service were made known, including the fact that certain services (such as frost forecasting) would subsequently have to be purchased from private weather services rather than provided free by the Government, and that some Weather Bureau stations would be closed. Although these actions are unrelated to the issue of transferring the satellites to the private sector, they were all linked together in the press and the public mind.

A third complication arose when it was revealed that the Department of Commerce official in charge of studying the satellite transfer issue had been approached by Comsat concerning future job opportunities, thus leading to at least the appearance of impropriety. [9]

Thus the issue of transferring Landsat to the private sector has become tangled with many other issues which will ultimately have to be sorted out by Congress before action takes place. In fact, language requiring congressional consultations on the transfer plan was placed in several pieces of legislation, including an emergency jobs bill and the fiscal year 1984 NASA authorization bill.

EXPENDABLE LAUNCH VEHICLES

Another area in which policy is expected soon is the commercialization of expendable launch vehicles (ELV's). These rockets are the type which have been used since the beginning of the space program, and include all launch vehicles other than the Space Shuttle. In the United States, four ELV's are in use: Delta, Atlas-Centaur, Titan, and Scout. The last is a very small vehicle capable

[9] Washington Post, April 15, 1983, pp. A1, 12.

of placing only small payloads into orbit and is not being proposed for commercial operation.

In the case of ELV's, one issue involves Government subsidies, specifically whether the companies that are commercializing the vehicles should be required to pay back the Government for sunk costs in R&D. These have been roughly estimated as $91 million for Delta, $600 million for Atlas-Centaur, [10] and $1 billion for Titan 34D. [11] One argument is that these costs should be paid back to the Government since the companies will now be making profits on Government-developed hardware, while the counterargument is that neither the Space Shuttle nor the European Space Agency's Ariane launch vehicle, with which these ELV's would compete for traffic, are expected to recover sunk costs in their pricing schemes, so the commerializers of the ELV's should also not be expected to recover those costs.

The companies that are proposing commercialization of existing ELV's or constructing new ones are identified in the appendix. Unless they plan to build their own launch facilities (only two, ARC Technologies and Space Services, have indicated such plans), they will have to make arrangements for lease or purchase of Government facilities. In the case of the existing ELV's, all the pads are owned by the Air Force, although NASA currently leases the launch pads for Delta and Atlas-Centaur from the Air Force and a private company could sublease through NASA. Also, range safety services must be acquired to ensure, for example, that if the launch vehicle deviates from course it can be safely destroyed. These services are currently provided by the Air Force.

Other areas in which private companies launching ELV's would have to coordinate with the Government include complying with treaties such as the 1967 Outer Space Treaty which states that governments are responsible for all launches from their territory, and the 1972 Convention on International Liability for Damage Caused by Space Objects, which makes governments responsible for compensation for damage resulting from satellite launches (see part II). Launches would also have to be approved by the Federal Aviation Administration (FAA) for clearing the airspace during a launch, and frequencies for transmitting commands to and/or recieving data back from launch vehicles must be assigned by the Federal Communications Commission (FCC).

Only one private launch has successfully taken place to date—the 1982 test launch of Space Services' Conestoga rocket. The procedures required to gain approval for that launch were time consuming, and have led to the introduction of legislation in Congress to ease the way for companies wishing to pursue such activities. The bill introduced in the House by Congressman Dan Akaka (H.R. 1011) would designate the Department of Commerce as lead agency, while the Senate bill introduced by Senator Ernest Hollings (S. 560) would give that role to the FAA.

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[10] These costs were estimated by NASA and do not include the development of the Thor booster on which the Delta design is based, nor the Atlas vehicle from which the Atlas-Centaur combination developed. Telephone conversation, April 1983.

[11] DOD estimate. Telephone conversation, April 1983.

Suggestions have also been made that either the State Department or NASA serve that role—State Department because it is ultimately responsible for adherence to the treaties governing space activities, NASA because of its expertise. The problem with assigning responsibility to NASA is potential conflict of interest. NASA is in a dilemma with regard to the commercialization of ELV's because although it wants to promote space activities in the United States, it has developed the Space Shuttle, with which commercial ELV's would compete. The national policy is that once the Shuttle is fully operational, all Government utilization of ELV's will cease. It is difficult to establish a policy which on the one hand promotes broad opportunities for commercial space endeavors while not creating competition for NASA's own system.

A high volume of uses for the Shuttle must be found in order to ensure that it will meet its expected economies. Already NASA has had to change its pricing strategy just to maintain a competitive posture with regard to the Ariane launch vehicle developed by the European Space Agency (ESA). Instead of recouping full costs of the Shuttle, NASA will now charge only enough to recover operating expenses. The impact of a fleet of privately operated ELV's, while providing a boom for customers, could spell doom for the Shuttle.

The Government's policy to phase out ELV's is what led to the proposals to commercialize the ELV's, because the private sector senses that there will be a market both for the Shuttle and the existing type of launch services. An important factor in this argument is whether NASA will procure a fifth Space Shuttle orbiter, for that will partially determine how often the Shuttle will fly, and therefore how many payloads it can take into space. Without the fifth orbiter, the Shuttle may be overbooked and customers might be willing to switch to an ELV. Another factor is whether the Shuttle system will meet its expected launch rate of 24 launches per year with 4 orbiters, which would also affect the number of customers looking for alternative launch arrangements. Some might want to double book on an ELV as insurance against a potential catastrophic failure of one or more orbiters.

There are obstacles to commercial ELV operators, however. For example, the United States is no longer the only country offering space launch services. ESA is aggressively marketing its Ariane launch vehicle and planning improvements to make it even more versatile and capable. In addition, there are signs that the Soviet Union may start offering launches on a commercial basis.

Thus there is competition for ELV operators not only from the Shuttle, but from other countries. The Office of Management and Budget (OMB) denied NASA's request for funding to procure a fifth orbiter in fiscal year 1984 because it did not see a need for another orbiter to meet expected traffic demands, so it is unclear as to whether a market really exists for all these different types of launch services.

Another potential obstacle is national security considerations both in terms of what types of satellites can be launched without adversely impacting the interests of the United States, and possible restrictions on the export of launch vehicles or launch vehicle technology.

It should also be noted that two companies have financed or are financing the development of upper stages for use either with the Shuttle or with ELV's. McDonnell Douglas developed the payload assist module (PAM) for use either with its Delta or with the Shuttle at its own expense, and markets the stage commercially. Recently, NASA signed a cooperative agreement with Orbital Systems Corp. (OSC) to develop an upper stage with an intermediate range of capability called the transfer orbit stage (TOS). OSC will privately fund development of TOS, although NASA will provide technical oversight at no charge. Under the cooperative agreement, NASA has also promised not to develop a similar vehicle of its own, although this does not preclude development by another company. NASA had been planning to develop such a stage itself until OSC offered to fund the project. If OSC drops out for any reason, NASA has indicated that it will step in. [12]

MATERIALS PROCESSING IN SPACE

The single area in which most discussion is heard concerning commercial space opportunities, or the "industrialization" of space, is in materials processing in space (MPS). Although NASA has very limited experience with MPS (only about 8 hours worth of experiments were conducted during the Apollo and Skylab programs) there is hope that there may be major industrial opportunities in this area.

NASA has two types of agreements which it offers in terms of MPS experiments; there is no exchange of funds in either case. One is the joint endeavor agreement in which NASA and the sponsoring organization share data from an experiment in return for a free Shuttle launch. There are only two existing joint endeavor agreements on MPS. One is with McDonnell Douglas working with Johnson and Johnson on electrophoresis experiments; this experiment has flown on two Shuttle missions already. The second is with Microgravity Research Associates to develop a process for the production of semiconductor materials. Another joint endeavor agreement, with GTI Inc. for the development of a furnace for use in MPS, was terminated after 1 year because GTI saw no immediate market for the device.

The other type of agreement is a technical exchange agreement in which companies are allowed to use existing NASA facilities for MPS experiments in return for data from the experiments. These facilities include, for example, sounding rockets, drop-tubes, and aircraft which fly in hyperbolic curves to create a few seconds of zero-g. NASA currently has technical agreements with John Deere, Honeywell, Dupont, and Inco. In addition to the activities done in cooperation with NASA, some companies are pursuing MPS research on their own. These companies are identified in the appendix.

The major obstacles in the path of MPS include lack of knowledge about the products or processes that might be developed in space factories because so little experimental work has been done, and the lack of orbital facilities for companies who want to per-

[12] Telephone conversation with a NASA representative, April 1983.

form MPS experiments. These issues underscore the importance of the debate over the proper role of the Government versus the private sector in such endeavors. There is a feeling among the private sector that NASA should be provided with more funding to perform basic research needed to identify the directions in which a company could proceed in order to develop a profitmaking enterprise, but NASA's space science and applications budget has been sharply constrained in the past few years. Also, there is the problem of who should develop the hardware for MPS. For example, one company representative explained that GTI Inc.'s decision to terminate its agreement with NASA for development of a furnace for MPS has left them in a quandry because there is no furnace available at this time suitable for their experiments. They do not want to spend money to develop a furnace themselves, so the future of their MPS program is in doubt. The representative stated that it did not matter to his company whether it leased facilities from NASA or from a private company such as GTI, just so it did not have to be responsible for providing such hardware. [13] Without the GTI agreement, however, which was terminated for lack of a defined market, the question remains as to who will develop the hardware.

Other areas in which concerns have been expressed include patent law and protection of proprietary information. These issues are discussed in part II of this report.

SPACE SHUTTLE

Operation of the Space Shuttle

Who should operate the Space Shuttle once it is no longer in an R&D phase has been a question debated for many years—without resolution. Communications, weather, and remote sensing satellites have all been transferred out of NASA once they were operational, so the question has arisen as to whether the Shuttle, too, should be transferred to another Government agency, the private sector, or a quasi-governmental organization.

A discussion of the options available for commercial operation of the Shuttle is beyond the scope of this report. Consequently, only the major policy issues will be identified. The first concerns military payloads. Assuming that DOD would not want to be dependent upon a commercial company for launch services, one option is to have DOD operate the entire Shuttle fleet. A second option would be to give DOD its own fleet of Shuttles while having a separate fleet for commercial and civil space flights (called "blue" and "white" fleets respectively). Of course, DOD might be persuaded to buy launches from a commercial company as long as certain safeguards and contingencies were provided for.

If NASA were to retain operational responsibility, the issue arises as to whether its budget would be adequately augmented to provide for whatever changes the agency would have to make organizationally and in hiring personnel. The NASA budget has been constrained for many years already because of the investment in the Space Shuttle, and concern might arise as to the health of

[13] Telephone conversation with representative of John Deere, Co., April 1983.

other NASA activities if large sums continued to be required for the STS system.

It is commonly argued, however, that the Government simply is not good at marketing what it develops and, once operational, a system should be handed over to the private sector. If this is done, the issue of Government subsidies will arise, both in terms of whether or not a private company would be required to pay back the Government for some or all of the sunk costs in the Shuttle, and in terms of whether the Government would be willing to subsidize a company in order to ensure that it could price Shuttle launches competitively with other launch vehicle options, particularly foreign ones. On the other side of the question is what, if any, restrictions the Government might impose on pricing. For example, NASA currently does not permit McDonnell Douglas to charge more than 30 percent of the internal rate of return (IRR) for the payload assist module. [14] Similar strictures might be imposed on Shuttle pricing as well, possibly making such an enterprise less attractive to the private sector.

As in the case of remote sensing satellites, there is the issue of how much it might cost the Government to buy back into the Shuttle system if the private entity decided to terminate its involvement because it was not profitable.

Another issue is who would perform R&D associated with improving the Shuttle system. Proposals have already been made to develop an unmanned version of the Shuttle (called SRB-X) using the solid rocket boosters for a heavy lift capability, and other improvements are likely to be identified as experience with the vehicle grows. If the private sector takes over operation of the Shuttle, would it be responsible for improvements, or would the Government continue to fund such activity as it has with communications satellites?

Shuttle-related hardware opportunities

The Shuttle also presents other commercial opportunities. The Shuttle is often described as a space truck, hauling cargo back and forth into space. Long-term facilities, either unmanned platforms or manned space stations, may be built by the Government or by the private sector to augment the Shuttle. It is generally accepted that the private sector cannot afford a massive R&D investment such as that needed for a manned space station, although one company, Space Industries, is discussing with NASA the possibility of a joint development. There also has been one proposal for an unmanned platform. Called Leasecraft, the device would provide power and communications subsystems, as well as an orbital maneuvering capability if refueled in space, for factories and perhaps observatories. The proposal is being made by Fairchild Industries and is based on the multimission modular spacecraft it developed for NASA and which has been used for the Solar Maximum Mission and Landsat 4. In addition, two companies have shown interest in designing facilities for use in the Shuttle cargo bay (see appendix).

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[14] Meeting with NASA representative, April 1983.

Other opportunities may also present themselves in areas such as providing in-orbit power supplies for the Shuttle to allow it to stay in orbit for extended periods of time, development of a reusable Space Tug, development of a teleoperator retrieval system, and so forth. Although these are areas in which industry expects (or at least hopes) that NASA will take the lead, if it does not, the private sector may wish to proceed itself.

Private purchase of a fifth Shuttle orbiter

A different kind of proposal related to the Space Shuttle is one by SpaceTran Inc. to purchase a fifth Shuttle orbiter for NASA in exchange for marketing rights to commercial and foreign payloads. The first informal proposal was submitted to NASA in the spring of 1982 and reportedly asked for exclusive marketing rights to all Shuttle commercial and foreign payloads. Following discussions with NASA, this apparently has been modified, but the details have not been released.

In early 1983, Federal Express agreed to purchase 20 percent of SpaceTran and the company is now reassessing its plans. Although SpaceTran was expected to resubmit a plan to NASA on March 1, 1983, none had been submitted at the time this report was prepared. (SpaceTran is also working with Martin Marietta on the commercialization of the Titan launch vehicle.)

The SpaceTran offer not only demonstrates interest from the private sector in the Shuttle system, but would save NASA approximately $1 billion if approved. Although OMB rejected NASA's request to purchase a fifth orbiter because it did not see a market for it in the projected Shuttle flight manifest over the next decade, apparently SpaceTran is confident that such a market exists.

Payload and Space Shuttle processing

Also associated with the Space Shuttle are plans for building processing facilities at Kennedy Space Center. At the present time, NASA processes the payloads for both the Shuttle and ELV's, but the NASA facility is overloaded. Astrotech International is now building a complementary facility near KSC and has arrangements with NASA to ensure that payloads processed there will meet NASA standards, although these arrangements are only in an exchange of letters, not through a formal mechanism such as a cooperative agreement or memorandum of understanding. [15] Hughes Aircraft also is actively considering construction of a payload processing facility near KSC in conjunction with a facility for satellite assembly. [16]

NASA is also getting close to choosing a company for its Shuttle processing contract (SPC) at KSC. This will involve onsite processing (preparation for launch) of the Shuttle itself rather than its payloads, and is expected to be a multimillion dollar contract over several years. The SPC will cover Shuttle processing both at KSC and at Vandenberg Air Force Base, which will be the west coast launch site for the Shuttle beginning in 1985. Currently, Shuttle processing is performed by several contractors that supply the

[15] Telephone conversation with Astrotech International representative, April 1983.
[16] Telephone conversation with Hughes representative, May 1983.

flight hardware (Rockwell International, Martin Marietta, and United Space Boosters, Inc.). The SPC would consolidate this activity. [17] This is not directly related to the issue of whether and how to commercialize the Shuttle, but is seen as a step in making the Shuttle ready for its operational era, whatever arrangements are ultimately chosen.

Policy Issues

Although each of the areas discussed above presents unique policy questions, there are also broad issues which affect more than one area. Some of these have been mentioned already, but this section will summarize them. Legal issues are discussed in part II of this report.

PROPER ROLE OF THE GOVERNMENT IN SPACE COMMERCIALIZATION

Subsidies/financing mechanisms

There are several different ways in which the Government might wish (or be expected) to subsidize commercial space ventures: Through guaranteeing purchase of certain amounts of data or numbers of vehicles such as upper stages; through direct subsidies to make a commercial venture competitive with foreign systems; through not requiring payback of sunk Government costs in a system; or through tax incentives.

In an era of tight budgets, Government subsidies are viewed with increasing concern, but they may be necessary if it is decided that transferring these systems to the private sector and/or maintaining U.S. competitiveness with foreign systems such as Ariane have an overriding importance. Many of the programs which are being considered as commercial prospects do not have defined markets, making them less attractive for private investment. Without guarantees that, at least, no money will be lost, the private sector simply may not be willing to get into the space business.

One alternative that has been discussed is the potential of establishing a Space Bank or Space Industrialization Corporation to provide venture capital/financing for commercial space endeavors. These proposals have been viewed as premature for the past several years, but might bear reexamination at this time. They might require Government funding initially, but are meant to be self-supporting eventually.

Related to this issue is how much it might cost the Government to buy back into a system that had been transferred to the private sector, but which was not profitable. Without subsidies to ensure financial success for a company, the Government might end up, for example, without remote sensing data or access to appropriate upper stages. In some cases, the only alternatives might be to purchase the data or hardware from other countries, or to reinstate Government ownership of the system. Thus, the advantages of commercialization must be weighed against the potential failure of a commercial endeavor and resulting costs to the Government.

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[17] Proposals Requested for Shuttle Processing Contract. NASA Press Release 83-3. Jan. 20, 1983.

Federal role in research and development

The issue of what role the Government should play in research and development vis-a-vis the private sector has been debated for many years. In the space business, this has been particularly visible in the case of advanced communications satellites R&D. NASA performed such R&D long after commercial communications satellites were available, but in 1973 the NASA program was terminated on the basis that the private sector should bear responsibility for advanced R&D. The private sector did not pick up the challenge, because they said it was too expensive, and NASA reentered the field in 1979. During that time, however, foreign countries such as France and Japan forged ahead in the technology.

With increasing space commercialization, the issue of who should perform both basic and advanced R&D will take on greater import. If systems such as the Space Shuttle, remote sensing satellites, and MPS are to continue to evolve, the Government may have to provide funding if the private sector is unwilling or unable to fund the R&D.

In the case of MPS, for example, the basic R&D must be done before a company can identify profitable directions to pursue. NASA has developed mechanisms such as joint endeavor agreements to encourage private sector participation in MPS, but no funding is provided and the experiments can prove prohibitively expensive for an interested company. It may be necessary to increase support for initial R&D funded by the Government if commercial activity is deemed important. A related issue is development of hardware needed for experimentation. Companies that might be willing to pay for an MPS experiment might not be willing or able to develop their own facilities, such as furnaces, which are not now available from NASA or private companies. A joint endeavor agreement between NASA and GTI Inc. for development of a furnace was terminated for lack of an identifiable market. Who then will develop such devices?

If the Government performs the R&D, another aspect of the issue is the relationship between the Government and the private sector in establishing what research should be done. NASA has been criticized in the past for performing R&D without adequate user input; steps might be taken to ensure maximum user involvement from the beginning.

Maintaining U.S. competitiveness with other countries

Both of the above issues are related to the question of how the United States can remain technologically competitive with other countries. This has been the subject of growing concern in the past few years, and one of the areas in which the United States has lost or is losing its lead is communications satellites.

The close relationship between Government and industry in foreign countries, unlike the separation between the two in the United States, is often viewed as creating unfair competition for U.S. goods and services. In the case of Ariane, for example, ESA has made it clear that it will subsidize that launch vehicle to whatever extent is necessary to make it competitive with the Space Shuttle. NASA is much more limited in what it can do to subsidize

the Space Shuttle without specific direction from the administration and Congress.

The 1958 National Aeronautics and Space Act states that the United States will remain a leader in world space activites, a theme echoed by recent administrations. If this truly is a major policy goal, then subsidies and Government sponsored R&D may be the sine qua non for maintaining that leadership.

Government fostering competition with itself

Apart from the question of U.S. competition with other countries is the question of how the Government can support commercial space endeavors without creating adverse competition for its own systems. A case in point is the commercialization of ELV's at the same time NASA is trying to prove the economies of the Space Shuttle system. This obviously creates quite a dilemma for NASA, which on the one hand is trying to encourage private sector interest in space, but on the other wants at least to break even on the Shuttle system. Statements from NASA officials show optimism that the Shuttle will prove itself in terms of economics as well as reliability, and the commercial ELV's will not seriously impact Shuttle business. Whether this is true or not remains to be seen. The question is whether NASA should actively encourage ELV commercialization, or simply endure it.

A related issue is what price controls NASA can impose on private sector operators and whether it could thereby unfairly affect the commercial attractiveness of ELV's. For example, NASA currently does not allow McDonnell Douglas to charge more than 30 percent of the internal rate of return on the PAM upper stages, and similar constraints might be placed on other systems.

NASA organization

An important aspect of the commercialization process is how NASA itself is organized to handle commercial proposals and how it communicates commercial opportunities to the private sector.

As described in the appendix, NASA has three different mechanisms for encouraging commercial space endeavors, but it is difficult to determine the differences between the three, what types of activities require what (if any) types of agreements in addition to those mechanisms (such as memoranda of understanding), and the status of various undertakings. Thus, it is difficult to determine the effectiveness of these mechanisms for promoting commercialization. Attention might be paid to the centralization of responsibility for these activities.

Another problem is how NASA educates the private sector about potential opportunities. For example, a criticism has been raised that NASA personnel involved in MPS research rarely give papers at technical meetings attended by scientists from the private sector who might benefit from that knowledge. Private meetings between specific companies and NASA representatives are hindered by limits on NASA's travel budget and restrictions on what the private sector is allowed to pay for without creating the appearance of impropriety between Government and industry. At the same time, NASA's budget for technology transfer and utilization activities is being cut. Mechanisms for better educating the private sector must

be developed if a commitment to commercialization of space is made.

Fifth orbiter/advanced in-orbit space facilities

Another factor which may impact on the commercialization of space is the availability of an adequate space transportation system and in-orbit space facilities, such as space stations or platforms, to support commercial activities.

One part of this concerns the debate over whether or not to procure a fifth orbiter. Although NASA and OMB agree that there is currently no requirement for a fifth orbiter, NASA is more optimistic that such a need will develop once the full potential of the space environment is realized. The question is whether the need will arise if there is no commitment to a fifth orbiter. A similar question arises with respect to space facilities, manned or unmanned, which would be needed for a full scale commercial enterprise.

Without commitments to these sorts of activities, a private company might not be willing to make the initial investment in research which would lead to future commercial activities, since there would be no guarantee that it could make use of whatever knowledge it gained.

Regulatory Issues

Regulatory issues are likely to arise as various space activities become more commercialized. At the present time, ELV's can serve as an example of some of the considerations that must be taken into account.

Types of satellites to be launched

Restrictions may have to be placed on the types of satellites that can be launched by the private sector. It is assumed that space systems with aggressive missions, such as antisatellite devices, would not be launched by a private company. But what if another country wanted to launch a military reconnaissance satellite? Or a navigation satellite intended primarily for civil use, but which could be diverted to military uses in times of crisis? Would such a launch be prohibited? Would it only be prohibited if it took place from U.S. soil, or could a company sell its launch vehicle to another country for launch from another site?

Similarly, how will restrictions on the resolution of remote sensing satellites be enforced for private operators (currently, the Government does not permit remote sensing satellites to have better than 10 meter resolution)? Will these restrictions apply to satellites constructed by other countries but launched by U.S. firms?

Regulations concerning export of launch vehicles/technology

Will private firms be allowed to export launch vehicles for launch from another country's launch site? This is important not only in terms of what type of satellite could be launched as noted above, but what the launch vehicle itself might be used for. Most launch vehicles (including Delta, Atlas, and Titan) were developed from military IRBM or ICBM technology. Assurances might have to be gained from the receiving country that they would not be

placed back into military service, as was done when Japan was allowed to manufacture Delta launch vehicles under license from McDonnell Douglas. With the growing awareness of the "giveaway" of U.S. technology to other countries, concerns might also be raised about how the launch vehicle technology might be used.

Lead agency identification

There are many other regulations concerning ELV's that will have to be dealt with, including assurances that launches will not violate treaties to which the U.S. is a signatory, the use of radio frequencies, clearing airspace around the launch site, and so forth. These have already been widely discussed in congressional hearings and the trade press. Legislation has been introduced in the House and Senate concerning designation of a lead agency as the point of contact for private firms wishing to engage in commercial ELV activity. Ostensibly this would ease the way for the private sector, making such endeavors more attractive, and might also serve the Government's interest in terms of coordinating procedures.

If a lead agency is designated, the question arises of which agency it should be. Four agencies have been mentioned: The Department of Commerce, the Department of Transportation (specifically the FAA), the Department of State, and NASA itself. The House bill (H.R. 1011) recommends the Department of Commerce since it is sensitive to the needs of the private sector, while the Senate bill (S. 560) recommends FAA since it has experience in the related area of aeronautics. Department of State has been suggested (so far informally) perhaps because it is ultimately in charge of adherence to treaty obligations, and NASA has been mentioned because of its obvious expertise in the space launch business, although it might have a conflict of interest since commercial ELV's would be competing with its Space Shuttle. One suggestion has been to name NASA as an interim contact point, while deferring a decision on what agency should serve as the lead.

Role of State and local governments

The above issues discuss possible regulations by the Federal Government, but State and local governments may also have a role to play, especially if new launch sites are established within their borders. For example, Space Services Inc. launched the Conestoga rocket from Texas and there has been some discussion of establishing a launch site in Hawaii. What role the State and local governments should play will need to be determined in the near future, particularly with regard to coordination with the Federal Government.

Monopolies

A major issue during consideration of the 1962 Communications Satellite Act was how to prevent a monopoly from developing in the area of providing satellite communications services. Similar concerns will likely develop in the commercialization of other space technologies, and have, in fact, already been raised in connection with the land and weather satellites, and ELV's.

National Security

National security issues are also likely to impact on commercialization decisions such as who should operate the Space Shuttle, access to commercial ELV's by DOD in times of crisis, access to privately owned launch sites in times of crisis, resolution limits on remote sensing satellites, use of commercial ELV's by foreign governments, and technology transfer in general (including, for example, building ground stations in foreign countries for receiving data from U.S. commercial satellites such as those proposed by American Science and Technology for remote sensing). One question is what agency should be responsible for ensuring that national security issues are resolved. DOD would seem a natural choice, but also might be viewed by the private sector as placing too many constraints on operations, so a more neutral agency, perhaps one of those being considered for lead agency responsibility for ELV's, might be designated instead.

Conclusion

The field of space commercialization is expanding rapidly. Many companies are showing interest in commercial space activities ranging from expendable launch vehicles to remote sensing satellites to materials processing in space.

President Reagan's 1982 space policy states that commercial space endeavors are to be encouraged as long as they are consistent with national security, but many policy issues remain to be resolved. The expeditious resolution to these many issues is needed if commercialization is to proceed full pace, but their complexity makes such quick action unlikely. In the meantime, consideration might be given to providing NASA with direction and funding required to centralize its activities related to commercialization and to perform necessary research and development to provide a sound basis upon which the private sector can make decisions about investing in space. Additional NASA resources may be needed for educational functions to increase the awareness of private companies as to what opportunities already exist.

PART II: THE COMMERCIALIZATION OF SPACE TECHNOLOGIES: SOME PRESENT AND FUTURE LEGAL ISSUES

Prepared by Daniel Hill Zafren, Specialist in American Public Law, American Law Division, Congressional Research Service.

INTRODUCTION

An attempt is made here to discuss and analyze some of the diverse and complex aspects of legal control that are or may deserve consideration in the commercialization of space technologies, that is, in the transition of Government owned and operated civilian space activities to strictly private ownership and operation, or civilian space activities originating through private initiative. By necessity, this overview must in large part be general in nature. A more particular assessment would have to be premised on the specific facts and circumstances surrounding any such actual transfers or ventures. Such items as the type and scope of the activity, the location of its inception and operation, and the nature of the entities participating, may be of special relevance. Positions and viewpoints of participants, existing and potential competitors, consumers and users, governmental agencies, international organizations, or other nations, might be germane to legal considerations or determinations.

Thus, the present and future legal issues raised here require an international law as well as a domestic regulatory diagnosis. This entails a narrow circumspection based on the particular space activity involved, and a broader evaluation covering regulations or controls over business activity and technological development in general.

INTERNATIONAL LEGAL RESPONSIBILITY AND LIABILITY

No matter what the form and content of the arrangement for the United States to domestically shift the ownership and control of its space activities, any such unilateral act would appear to be without international legal effect. Thus, it would be the United States itself that would be held accountable under treaty law and customary international law for the obligations and responsibilities concerning such activities or even "pure" private activities. Internationally, such a transfer would appear to place the United States in a theoretical dichotomy. It will have given certain direct rights and privileges it has enjoyed under international law to the private commercial interests of its citizenry while still being primarily liable for a wide array of adverse effects that might emanate from the exercise of those rights. Since Article 6, Cl. 2 of the Constitution of the United States makes treaties the supreme law of the United States, U.S. citizens would be bound as a matter of domestic law by the self-executing provisions of space treaties in exercising actions or

activities covered thereby, and the authority settled upon by the United States governing any transfer might expressly provide for actual fulfillment of international requirements. However, such would not displace the United States as an actual obligor under international law.

SPACE LAW TREATIES

Four major multilateral treaties, drafted and signed under United Nations auspices, comprise the corpus of space law today. The so-called Outer Space Treaty [1] is the most fundamental agreement, and the one upon which the later treaties were elaborated or expanded upon. Probably the most germane provision for the purposes of the discussion here is that portion of Article VI which reads:

> ARTICLE VI
>
> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by nongovernmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of nongovernmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty.

Importantly, this provision makes no distinction between activities carried out by the State itself or by its private commercial enterprises. Thus, it would be applicable to all space activities, such as telecommunication satellite activities. "Therefore, as opposed to the traditional rule in telecommunications, States are responsible for outer space activities carried out by any of their private nationals and firms, even if the State does not exercise any direct or indirect control over such activities. Indeed, failure to undertake this responsibility would constitute a breach of the principle of control and supervision over non-governmental entities as stated in the second sentence. . ." [2]

Some other basic obligations and responsibilities can be found in the Outer Space Treaty. The premise for international liability for damage is set forth in Article VII:

> ARTICLE VII
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> Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is in-

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[1] Treaty of Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, January 27, 1967[1967], 18 U.S.T. 2410, T.I.A.S. 6347

[2] N.M. Matte, *Aerospace Law-Telecommunications Satellites* (1982), at 81.

> ternationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the moon and other celestial bodies.

Retention of jurisdiction and control over objects in outer space is covered by Article VIII:

> ARTICLE VIII
>
> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

Some of the other obligations contained in this Treaty are: carrying on activities in accordance with international law (Article III); avoidance of contamination; avoidance of adverse changes in the environment of the Earth from the introduction of extraterrestrial matter; and international consultations in certain instances before proceeding with activities or experiments. There is, of course, room for great variation in interpretation of these or other prescriptions, as well as to whom, and to what extent they would actually apply. [3]

The so-called Astronaut Assistance and Return Agreement [4] elaborates on the general provisions of the Outer Space Treaty dealing with assistance to be given to astronauts, and provides for such matters as notification of accidents, and the rescue and return of spacecraft personnel and space objects. "Launching authority" as used in this treaty refers to the State "responsible" for launching (Article VI). A number of potential legal problems that might need addressing can be envisioned. For example, if there is a launching of a space object by private U.S. industry that falls within the territory of another Party to the Treaty, that Party's responsibility is to notify the launching State (the United States), and if requested by it and with its assistance to recover the object or its component parts and at the launching State's expense. What kind of obligation, including items such as timing, form and content, as regards sending or receiving such notifications would or should

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[3] Added uncertainity can be found concerning the pending so-called Moon Treaty. See. e.g., Congressional Research Service, Senate Committee on Commerce, Science, and Transportation, 96th Cong., 2d Sess. *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, Part 4 (Committee Print 1980).

[4] Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space, April 22, 1968 [1969], 19 U.S.T. 7570, T.I.A.S. No. 6599.

exist between the U.S. Government and the involved private industry? To what extent would or should each participate in the decision to request a return, the kind and participation of assistance, and the bearing of expenses? Additional legal complexities can be speculated on if the object lands in a nation not Party to the Treaty.

The so-called Outer Space Liability Convention [5] establishes the rule of absolute liability for a launching State for losses suffered by persons (other than its nationals) and property from reentering space objects and their components. Even though this Treaty has been the subject of criticism as being legally inadequate to govern many liability questions concerning space activities, [6] since a launching State is defined therein as including a State from whose territory or facility a space object is launched, the United States has a potential absolute and unlimited liability for deaths, injury or damage caused by space objects (or their parts) launched by its nationals from within its territory or from a facility of the United States (even if on the high seas). A resolution of how such liability should be affixed in such instances, including the manner in which claims are to be handled, would appear to be a major prerequisite for any domestic scheme to promote private space activities or any arrangement of transferring present Government operations or activities in space to the private sector.

The so-called Registration Convention, [7] requires a launching State (again defined as including a State from whose territory or facility a space object is launched) to enter each launching in an appropriate registry with certain information to be furnished to the Secretary General of the United Nations. The division/responsibility concerning such functions would also seem to be a matter for domestic operational agreement.

SOME OTHER TREATIES

A number of additional multilateral agreements to which the United States is a Party may be germane with respect to any particular kind of privately run activity, or possibly problematical with the U.S. (or its representative) membership in certain international organizations, or possibly contrary to or inconsistent with the rules set up thereunder. For example, Intelsat, the International Telecommunications Satellite [8] Organization, is an organization established for the purpose of continuing and carrying forward on a definitive basis, the design, development, construction, establishment, operation and maintenance of the space segment of the global commercial telecommunications satellite system. Recently, an application filed by a private corporation with the FCC seeking permission to build and launch two satellites over the Atlantic to

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[5] Convention on International Liability for Damage Caused by Space Objects, March 29, 1972 [1973], 24 U.S.T. 2389, T.I.A.S. No. 7762.

[6] See, e.g., M.D. Forkosch, *Outer Space and Legal Liability* (1982). For a favorable analysis, see C.Q. Christol, *The Modern International Law of Outer Space* (1982), at 59–104.

[7] Convention on the Registration of Objects Launched into Outer Space, January 14, 1975 [1976], 28 U.S.T. 695, T.I.A.S. No. 8480

[8] Agreement Relating to the International Telecommunications Satellite Organization (Intelsat), August 20, 1972 [1973], 23 U.S.T. 3813. Also, see, Operating Agreement Relating to the International Telecommunications Satellite Organization (Intelsat), August 20, 1971 [1973], 23 U.S.T. 4091.

provide transponders for multinational corporations, video networks and other entities wanting their own private network between the United States and Europe, has brought an outcry from an Intelsat official that a private Atlantic satellite network would threaten the integrity of Intelsat's global system and would be in violation of the Intelsat treaties.[9] Inmarsat, the International Maritime Satellite Organization,[10] is similar to Intelsat but is an international organization which provides the space segment for maritime satellite communications. Interestingly, both organizations allow a signatory to the operating arrangements to be a private entity, such as Comsat. If other private entities become involved with activities whereby it may be competitively necessary to receive information from Comsat as such a signatory, some legal prescription to that effect may be necessary.[11] Another example of potential conflict of roles the U.S. Government might be required to perform under international commitment and one that might emerge as in the best interests of an activity taken over by private industry could surface if weather satellites are sold to such private interests. The United States as a party to the Convention of the World Meteorological Organization[12] is a member of the international organization, the purpose of which are:

PURPOSES

The purposes of the Organization shall be

(a) To facilitate worldwide cooperation in the establishment of networks of stations for the making of meteorological observations or other geophysical observations related to meteorology and to promote the establishment and maintenance of meteorological centers charged with the provision of meteorological services;

(b) To promote the establishment and maintenance of systems for the rapid exchange of weather information;

(c) To promote standardization of meteorological observations and to ensure the uniform publication of observations and statistics;

(d) To further the application of meteorology to aviation, shipping, agriculture, and other human activities; and

(e) To encourage research and training in meteorology and to assist in coordinating the international aspects of such research and training.

CUSTOMARY INTERNATIONAL LAW

Even in the absence of any of the treaties discussed above, there has been a continuous flow of international decisions and practices to support the international principle of liability of a nation concerning acts carried out in its own territory that have an adverse

[9] *The Washington Post*, March 31, 1983.
[10] Done on September 3, 1976[1979], 31 U.S.T.1
[11] See, 48 Fed. Reg. 8462 (March 1, 1983) concerning the problem of Comsat relaying information to manufacturers in the United States of Earth station equipment.
[12] Done on October 11, 1947 [1950, 1 U.S.T. 281.

affect on the territory of another nation. [13] While this is not a fully settled point in international law, it would seem that an instance in which an activity instigated within a nation's territory and which is intended to be carried out over the territory of another nation, even if that first nation is legally entitled to do so, bolsters the possible application of this principle in the event of adverse consequences to that other nation's territory.

SOME UNRESOLVED INTERNATIONAL LEGAL PROBLEMS

If private industry supplants the Government in the conduct of certain space operations, the private sector could become more directly embroiled in a number of outstanding international controversies. It might well necessitate coordinating legal and foreign policy positions vis-a-vis the Government. Points of dissention exist with respect to the legal nature of the space environment itself or portions of it, national rights with reference thereto, and/or particular activities themselves either in their space contact or their effects on the Earth. Further complication is found in an intermeshing of many of these elements. Perhaps, much of the legal controversy can be attributed to the developed/developing nations dichotomy.

The delimitation of outer space

"The problem of whether and how to define outer space, particularly where to draw its lower limit and thus to distinguish it from airspace, belongs, without any doubt, to the oldest and most discussed questions of the law of outer space and its doctrine." [14] At the crux of this issue is the fact that different legal regimes and rights exist for airspace and outer space. Airspace is subject to the sovereign claim of the territory above it; outer space is not subject to any claim of sovereignty. Without a certain demarcation between these two regimes various degrees of legal uncertainty are raised, particularly as to activities that occur in both spheres. For example, in spite of administrative interpretation that the Space Shuttle is not an aircraft, there is an expression of opinion by some legal commentators that as a matter of law the Space Shuttle must be considered an aircraft while functioning in navigable airspace. [15]

The geostationary orbit

Closely related to the demarcation issue is the problem of the geostationary orbit—the equatorial orbit at which a satellite takes 24 hours to circle the Earth so that it is stationary as viewed from Earth, at an altitude of approximately 36,000 km. [16] Claims have been advanced to rights of sovereignty over certain segments of the geostationary orbit, and thereby a limited area of outer space, in

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[13] See, for example, *The Trail Smelter* case (*United States* v. *Canada*), 3 U.S.R.I.A.A. 1938 (1941); *The Corfu Channel* case [1949] I.C.J. 4; *The Lake Lannoux* case, 12 U.N.R.I.A.A. 281 (1957); and Nanda, *The Establishment of International Standards for Transnational Injury*, 60 Iowa L. Rev. 1089 (1975).

[14] Kopal, *The Question of Defining Outer Space*, 8 J. Space L. 154(1980).

[15] Robinson, *Private Management and Operation of the Space Shuttle: Some Legal Problems Related to Market Entry*, 13 Akron L. Rev. 601, 607 (1980).

[16] Office of Technology Assessment, *Solar Power Satellites* (OTA-E-144, August 1981), at 296 (Glossary).

favor of individual states located below such segments. The so-called Bogota Declaration [17] states in part: "There is no definition of outer space that is valid and satisfactory for the international community such as might be cited to support the argument that the geostationary orbit is included in outer space." The equatorial States basically use the stance represented by the New International Economic Order to substantiate their claim of sovereignty to such orbit as a natural resource. [18] The United States has, of course, rejected such a claim on scientific and legal grounds. [19] Yet, this legal issue subsists, accentuated by the practical reality that by far most communications satellites are those stationed in such orbit. [20]

Direct television broadcasting

The international community has not yet been able to formulate an international agreement on direct television broadcasting (whereby a broadcast goes from the satellite into a home receiver without any intervening relay action). The international issue here is open dissemination of ideas and information. Some States regard it as potentially introducing repugnant ideas into their territory. "The free transmission and reception of information is perceived differently in States possessing differing degrees of development and different ideological motivations." [21] The latest principles (which are not binding) can be found in an Annex to a General Assembly Resolution adopted in December 1982:

A. PURPOSES AND OBJECTIVES

1. Activities in the field of international direct television broadcasting by satellite should be carried out in a manner compatible with the sovereign rights of states, including the principle of nonintervention as well as with the right of everyone to seek, receive and impart information and ideas as enshrined in the relevent United Nations instruments.

2. Such activities should promote the free dissemination and mutual exchange of information and knowledge in cultural and scientific fields, assist in educational, social and economic development, particularly in the developing countries, enhance the qualities of life of all peoples and provide recreation with due respect to the political and cultural integrity of states.

3. These activities should accordingly be carried out in a manner compatible with the development of mutual understanding and the strengthening of friendly relations and cooperation among all states and peoples in the interest of maintaining international peace and security.

B. APPLICABILITY OF INTERNATIONAL LAW

4. Activities in the field of international direct television broadcasting by satellite should be conducted in accordance with international law, including the Charter of the United Nations, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, of 27 January 1967, the relevant provisions of the International Telecommu-

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[17] Declaration of the First Meeting of Equatorial Countries, signed on Dec. 3, 1976 by Columbia, Congo, Ecuador, Indonesia, Kenya, Uganda, Zaire, and Brazil (as an observer). 6 J. Space L. 193 (1978).

[18] E.g., see G.A. Res. 2692 (XXV) and G.A. Res. 3281 (XXV).

[19] U.S. Department of State, *Digest of United States Practice in International Law 1978* (1980), at 1189.

[20] Office of Technology Assessment, *Civilian Space Policy and Application*, OTA-ST1-177, June 1982, at 47.

[21] C.Q. Christol, *The Modern International Law of Outer Space* (1982), at 607.

nication Convention and its Radio Regulations and of international instruments relating to friendly relations and cooperation among states and to human rights.

C. RIGHTS AND BENEFITS

5. Every State has an equal right to conduct activities in the field of international direct television broadcasting by satellite and to authorize such activities by persons and entities under its jurisdiction. All states and peoples are entitled to and should enjoy the benefits from such activities. Access to the technology in this field should be available to all states without discrimination on terms mutually agreed by all concerned.

D. INTERNATIONAL COOPERATION

6. Activities in the field of international direct television broadcasting by satellite should be based upon and encourage international cooperation. Such cooperation should be the subject of appropriate arrangements. Special consideration should be given to the needs of the developing countries in the use of international direct television broadcasting by satellite for the purpose of accelerating their national development.

E. PEACEFUL SETTLEMENT OF DISPUTES

7. Any international dispute that may arise from activities covered by these principles should be setttled through established procedures for the peaceful settlement of disputes agreed upon by the parties to the dispute in accordance with the provisions of the Charter of the United Nations.

F. STATE RESPONSIBILITY

8. States should bear international responsibility for activities in the field of internatinal direct television broadcasting by satellite carried out by them or under their jurisdiction and for the conformity of any such activities with the principles set forth in this document.

9. When international direct television broadcasting by satellite is carried out by an international intergovernmental organization, the responsibility referred to in Paragraph 8 above should be borne both by that organization and by the states participating in it.

G. DUTY AND RIGHT TO CONSULT

10. Any broadcasting or receiving state within an international direct television broadcasting satellite service established between them requsted to do so by any other broadcasting or receiving state within the same service should promptly enter into consultations with the requesting state regarding its activities in the field of internatinal direct television broadcasting by satellite, without prejudice to other consultations which these states may undertake with any other state on that subject.

H. COPYRIGHT AND NEIGHBORING RIGHTS

11. Without prejudice to the relevant provisions of international law, states should cooperate on a bilateral and multilateral basis for protection of copyright and neighboring rights by means of appropriate aggreements between the interested states or the competent legal entities acting under their jurisdiction. In such cooperation they should give special consideration to the interests of developing countries in the use of direct television broadcasting for the purpose of accelerating their national development.

I. NOTIFICATION TO THE UNITED NATIONS

12. In order to promote international cooperation in the peaceful exploration and use of outer space, states conducting or authorizing activities in the field of international direct television broadcasting by satellite should inform the Secretary General of the United Nations, to the greatest extent possible, of the nature of such activities. On receiving this information the Secretary General should disseminate it im-

mediately and effectively to the relevant specialized agencies as well as to the public and the internationl scientific community.

J. CONSULTATIONS AND AGREEMENTS BETWEEN STATES

13. A state which intends to establish or authorize the establisment of an international direct television broadcasting satellite service shall without delay notify the proposed receiving state or states of such intention and shall promptly enter into consultation with any of those states which so requests.

14. An international direct television broadcasting satellite service shall only be established after the conditions set forth in paragraph 13 above have been met and on the basis of agreements and/or arrangements in conformity with the relevant instruments of the International Telecommunication Union and in accordance with these principles.

15. With respect to the unavoidable overspill of the radiation of the satellite signal, the relevant instruments of the International Telecommunication Union shall be exclusively appplicable.

Remote sensing

There has also been a failure internationally to agree on principles governing remote sensing (observing conditions on the Earth from a satellite), or even to agree on a working definition thereof. Basically, the dispute involved is the position of the sensed States (which, it seems, tend to usually be complaining developing nations) that there be some form of prior consent and that they have some rights concerning the information obtained and how it is distributed. [22]

Use of nuclear power sources

The use of nuclear power sources in outer space is another object of legal dispute, particularly on the safety and environmental concerns. While covered to some extent by the existing space treaties, a new agreement in the form of supplementation on areas as consultation, notification, emergency assistance, and liability and recovery of damages is yet to be agreed on. [23]

Common heritage of mankind

The developing nations believe that the provision in Article I of the Outer Space Treaty that outer space "shall be the province of mankind" articulates the "common heritage of mankind" concept. [24] Additional support is gleaned from the specific provision in the recently proposed Moon Treaty providing that the natural resources of the Moon "are the common heritage of mankind," and the recently advanced Law of the Sea Treaty declaring the area and its resources as the common heritage of mankind. [25] "The common heritage of mankind doctrine applies to the use of space by the placement of a craft in a specific location." [26]

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[22] Id., at 732-733.

[23] Id., at 765-810. Also, see 1982 Report of the U.N. Committee on the Peaceful Uses of Outer Space, at 8-9.

[24] Okolie, *Legal Interpretation of the 1979 United Nations Treaty Concerning the Activities of Sovereign States on the Moon and Other Celestial Bodies Within the Meaning of the Concept of Common Heritage of Mankind*, in Int'l Inst. of Space Law of the Int'l Astronautical Fed'n Proceedings of the Twenty-Third Colloquium on the Law of Outer Space 61, 64 (1981).

[25] Art. 136; 21 I.L.M. 1293 (1982).

[26] Tennan, *Outer Space: A Preserve for All Mankind*, 2 H. J. Int'l L. 145, 153 (1972).

> For developing countries, "common heritage" means common ownership of the resources and majority control over their disposition. This translates into insistence that no single country, or entity under its control, has the independent right to use the commonly owned resource. Access to the resources must first be approved by the international community on the basis of one nation-one vote. As a result, the developing countries would collectively control who is allowed to exploit and use the resource. The concept of the "common heritage of mankind" does not, in the view of the Third World, recognize that industrialized countries with space technology should have a greater voice in regulating outer space resource technology. [27]

In spite of a contrary legal posture by the United States and most legal commentators that the common heritage concept does not amount to an international legal doctrine, and which has no fixed meaning or binding effect, it does, at least, arguably raise some degree of apprehension on the certainty or recognition of the legal effects attached or attachable to acts or activities in outer space.

Present Domestic Regulatory Schemes

U.S. statutes and regulations that may be applicable to private activity in or concerning outer space are numerous and complex. A theoretical examination may be misleading because the application of each or any of them, in whole or in part, would depend on the numerous factors involved in an actual situation. There does not seem to be any existing strictly designed framework which either specifically disallows or fosters "pure" private commercialization of space or space activity. Congress, in the statutory creation of Comsat, a nongovernmental, forprofit corporation, to act for the United States in establishing and participating in an international, commercial communications satellite system, has expressly reserved the right to repeal, alter or amend this enabling legislation at any time, [28] besides providing for such things as the powers of the corporation [29] and annual reporting to the Congress on its activities and accomplishments. [30]

An attempt will be made here to point out some areas of regulation which appear to be adverse to or an encouragement of either private commercial actions in some specifically related activity or in general. Seemingly, more of these provisions appear to be of an adverse nature, but this does not necessarily mean that such private endeavors would be less legally feasible than other kinds of private commercial undertakings, or that the private bar could not meet the challenge of accomplishing an intended effect despite such adversity.

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[27] Dula, *Free Enterprise and the Proposed Moon Treaty*, 2 H. J. Int'l L. 3, 19-20 (1979).
[28] 47 U.S.C. §731.
[29] 47 U.S.C. §735.
[30] 47 U.S.C. §744.

FEDERAL DOMINANCE

The legal question to be addressed here is whether by virtue of the National Aeronautics and Space Act of 1958, [31] any and all private space activity can only be carried out under the aegis of NASA? With respect to civilian space activity, the act provides in part that activities in space "shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States..." [32] "Aeronautical and space activities" is defined as "(A) research into, and the solution of, problems of flight within and outside the Earth's atmosphere, (B) the development, construction, testing, and operation for research purposes of aeronautical and space vehicles, and (C) such other activities as may be required for the exploration of space. . . ." [33] One legal commentator has concluded that an activity such as private aerospace transportation would not be encompassed thereby because it would be operated for profit and not for research or exploration purposes, and that it is not "sponsored" by the United States. [34] Yet, it would seem that a strong argument can be made to support the position that all civilian space activity could fall within the purview of the act. First, the legislative history of the act appears to support a contention that the only activities excludable from potential coverage were those "aeronautical" activities in existence in 1958, and that exploitation activities as well as exploration ones are included. The conference report, in discussing definitions, states in part: "The purpose is to make clear that the act is concerned primarily with research, development, and exploration. The use of the word "activities" is intended to be broad in the area of outer space because no one can predict with certainty what future requirements may be. . . . These activities would include scientific discovery and research not directly related to travel in outer space but utilizing outer space, and the development of resources which may be discovered in outer space." [35] Second, sponsorship would arguably include other actions or situations than where there is Federal funding and substantial Federal supervision. The plain meaning includes "one who assumes responsibility for some other person or thing." [36] As previously discussed, the United States is internationally responsible for private space activity, and Congress has expressly declared responsibility for all activities in space in the act. [37]

Another area of Federal dominance appears to be NASA's authority to initiate and carry out a program of research, technology, monitoring, and other appropriate activities directed to understanding the physics and chemistry of the upper atmosphere. [38]

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[31] 42 U.S.C. §2451 et seq.
[32] 42 U.S.C. §2451 (b)
[33] 42 U.S.C. §2452(1)
[34] Dula, *Regulation of Private Commercial Space Activities*, 23 Jurimetrics, 156, 160-163 (1983).
[35] H. Rep. No. 1758, 85th Cong., 2d Sess (1958); 1958 U.S. Code Cong. and Admin. News 3186, 3192-3193.
[36] Webster's New Collegiate Dictionary (1973).
[37] 42 U.S.C. §2451 (b)
[38] 42 U.S.C. §2483 (b)

NASA has taken a seemingly broader approach through "Joint Endeavor Agreements" a form of NASA/industry relationship to encourage private sector participation in certain research. [39]

MULTIPLE FEDERAL AGENCY JURISDICTION

Various, overlapping and perhaps conflicting jurisdiction over certain space activities may be exercised by a number of Federal administrative agencies. Private rocket launching is perhaps the prime example. The Federal Aviation Act of 1958 authorizes regulations to, inter alia, prevent collision between aircraft and airborne objects. [40] The FAA has promulgated the following with regard to operating limitations and notice requirements for unmanned rockets: [41]

§101.23 Operating limitations.

No person may operate an unmanned rocket—

(a) In a manner that creates a collision hazard with other aircraft;

(b) In controlled airspace;

(c) Within five miles of the boundary of any airport;

(d) At any altitude where clouds or obscuring phenomena of more than five-tenths coverage prevails;

(e) At any altitude where the horizontal visibility is less than five miles;

(f) Into any cloud;

(g) Within 1,500 feet of any person or property that is not associated with the operations; or

(h) Between sunset and sunrise.

(Sec. 6(c), Department of Transportation Act (49) U.S.C. 1655(c))

[Doc. No. 1580, 28 FR 6722, June 29, 1963, as amended by Amdt. 101-4, 39 FR 22252, June 21, 1974.]

§101.25 Notice requirements.

No person may operate an unmanned rocket unless, with 24 to 48 hours before beginning the operation, he gives the following information to the FAA ATC facility that is nearest the place of the intended operation:

(a) The names and addresses of the operators.

(b) The number of rockets to be operated.

(c) The size and weight of each rocket.

(d) The maximum altitude to which each rocket will be operated.

(e) The location of the operation.

(f) The date, time, and duration of the operation.

(g) Any other pertinent information requested by the ATC facility.

The Department of State might assert some jurisdiction based on its authority under the Arms Export Control Act [42] and its accompanying regulations concerning launch vehicles and rockets. [43] NASA could probably assert jurisdiction under the broad sweep of the National Aeronautics and Space Act, [44] particularly if NASA installations are used. [45] The FCC could probably assert jurisdic-

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[39] See, Office of Technology Assessment, *Civilian Space Policy and Applications*, OTA-STI-177, June 1982, at 232-234.

[40] 49 U.S.C. §1348 (c)

[41] Title 14, Code of Federal Regulations (CFR).

[42] 22 U.S.C. §2778.

[43] 22 CFR §121.01

[44] 42 U.S.C. §2451 et seq.

[45] 14 CFR, Part 1204, Subpart 10. If launching pads of the Air Force are involved, the Department of the Air Force may also be an interested agency.

tion by virtue of the communications frequencies required in a launching under its authority granted by the Federal Communications Act of 1934.[46] A "rocket" also falls within the definition of "destructive device" under the firearms provisions of the Criminal Code[47] and, therefore, some assertion of jurisdiction might be made by the Bureau of Alcohol, Tobacco and Firearms. If special taxes are involved, the Internal Revenue Service also might step in.

Besides this potential Federal governmental involvement, it is conceivable that some of the States might assert some jurisdiction if, for example, the launching takes place within that State or the private entity conducting the launching is organized under that State's laws, and the State(s) have relevant legislation such as dealing with rules of conduct for aeronautical and/or hazardous activities.[48] It is even possible that certain local laws and regulations might be applicable. Related activities could also be covered by a myriad of laws, for example, Federal, State, and local labor laws concerning the rocket launching personnel.

PATENTS

There appears to be a great deal of confusion concerning the rights to inventions which have significant utility in the conduct of space activities, particularly where some contract exists with NASA. At the very least, it would seem that a private entity would or might be subjected to a more protracted and cumbersome procedure in obtaining such a patent than with other commercial inventions. The pertinent provisions in section 305[49] of the National Aeronautics and Space Act of 1958 read as follows:

PATENT APPLICATION

(c) No patent may be issued to any applicant other than the Administrator for any invention which appears to the Commissioner of Patents to have significant utility in the conduct of aeronautical and space activities unless the applicant files with the Commissioner, with the application or within thirty days after request therefore by the Commissioner, a written statement executed under oath setting forth the full facts concerning the circumstances under which such invention was made and stating the relationship (if any) of such invention to the performance of any work under contract of the Administration. Copies of each such statement and the applications to which it relates shall be transmitted forthwith by the Commissioner to the Administrator.

ISSUANCE OF PATENT TO APPLICANT; REQUEST BY ADMINISTRATOR; NOTICE; HEARING; DETERMINATION; REVIEW

(d) Upon any application as to which any such statement has been transmitted to the Administrator, the Commissioner may, if the invention is patentable, issue a patent to the applicant unless the Administrator, within ninety days after receipt of such application and statement, requests that such patent be issued to him on behalf of the United States. If, within such time, the Administrator files such a request with the Commissioner, the Commissioner shall transmit notice thereof to the applicant, and shall issue such patent to the Administrator unless the applicant within thirty days after receipt of such notice requests a hearing before a Board of Patent Interferences on the question whether the Administrator is entitled under

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[46] 47 U.S.C. §151 et seq.
[47] 18 U.S.C. §921 et seq.
[48] For example, the Code for Unmanned Rockets, N.F.P.A. 1122L. Dula, *Regulation of Private Commercial Space Activities*, 23 Jurimetrics 156, 175 (1983)
[49] 42 U.S.C. §2457(c)(d)(e).

this section to receive such patent. The Board may hear and determine, in accordance with rules and procedures established for interference cases, the question so presented, and its determination shall be subject to appeal by the applicant or by the Administrator to the Court of Customs and Patent Appeals in accordance with procedures governing appeals from decisions of the Board of Patent Interferences in other proceedings.

FALSE REPRESENTATIONS; REQUEST FOR TRANSFER OF TITLE TO PATENT; NOTICE; HEARING; DETERMINATION; REVIEW

(e) Whenever any patent has been issued to any applicant in conformity with subsection (d) of this section, and the Administrator thereafter has reason to believe that the statement filed by the applicant in connection therewith contained any false representation of any material fact, the Administrator within five years after the date of issuance of such patent may file with the Commissioner a request for the transfer to the Administrator of title to such patent on the records of the Commissioner. Notice of any such request shall be transmitted by the Commissioner to the owner of record of such patent, and title to such patent shall be so transferred to the Administrator unless within thirty days after receipt of such notice such owner of record requests a hearing before a Board of Patent Interferences on the question whether any such false representation was contained in such statement. Such question shall be heard and determined, and determination thereof shall be subject to review, in the manner prescribed by subsection (d) of this section for questions arising thereunder. No request made by the Administrator under this subsection for the transfer of title to any patent, and no prosecution for the violation of any criminal statute, shall be barred by any failure of the Administrator to make a request under subsection (d) of this section for the issuance of such patent to him, or by any notice previously given by the Administrator stating that he had no objection to the issuance of such patent to the applicant therefor.

The courts have held that when an invention is developed under contract with NASA and subsequently reduced to practice outside the contract, the invention can be considered to have been made as a result of the contract. [50] "Contract" is broadly defined as including "any actual or proposed contract, agreement, understanding, or other arrangement, and includes any assignment, substitution of parties, or subcontract executed or entered into thereunder. . . ." [51] However, it appears that NASA has taken a restrictive view of this provision and not all actions which literally might fall within it have been so included, for example, joint endeavors, in order to maintain private incentive and initiative. [52]

COMSAT

Comsat was created as a private corporation "subject to appropriate Government regulation" as the U.S. participant in a global communications satellite system, with such entity to be the U.S. representative in Intelsat and Inmarset. [53] The existence of this private commercial entity has at least two possible legal inhibitions to the entry of other commercial endeavors either using such communication services or perhaps dependent on the inner workings of these two international organizations. The enabling act provides: "It is not the intent of Congress by this act to preclude the use of the communications satellite system for domestic communication services where consistent with the provisons of this act nor to pre-

[50] *Hummer* v. *Administrator of the National Aeronautics and Space Administration*, 500 F.2d 1383, 1388 (Cust. & Pat. App. 1974).
[51] 42 U.S.C. §2457(j)(2).
[52] See NASA Memo of June 19, 1979 from Assistant General Counsel for Patent Matters to General Counsel on "Applicability of Section 305 of the Space Act to Joint Endeavors." Such is actually incorporated in the Joint Endeavor Agreements.
[53] 47 U.S.C. §701 et seq.

clude the creation of additional communications satellite systems, if required to meet unique governmental needs or it is otherwise required in the national interest." [54] Thus, it would seem that for a private commercial entity to use the system for domestic communications services in addition to compliance with general provisions of law it would be confined to activities "consistent" with this act. To establish an additional communications system, a potential entrant would have to show that such is required to meet unique governmental needs or in the national interest. Further, by virtue of Comsat's privileged position in Intelsat and Inmarsat, it would be privy to the workings or direction of thinking of those organizations at an earlier time than other, competing U.S. commercial entities. In recent regulations of the FCC amending rules and policies to conform with the Inmarsat system, the following issue is stated (but not discussed as the rule purportedly covers this point): "[S]ignatories of other countries in the Inmarsat Organization provide to their manufacturers important Inmarsat documents concerning ship earth station specifications which are not made available by the U.S. Signatory, Comsat, to its manufacturers. As a result, manufacturers in other countries have the opportunity to examine these documents in draft form and have an early knowledge of Inmarsat thinking. This gives them a competitive advantage in their business activities with the U.S. manufacturers." [55]

LAWS OF GENERAL APPLICABILITY

In addition to any specific regulatory restrictions, laws of a more general nature may apply to the entry into and/or conduct of operations of space commercial ventures. For example, anticompetitive behavior by and between commercial entities would be subject to the Federal (and State) antitrust laws. One of these laws, the Sherman Act, [56] prohibits contracts, combinations or conspiracies that unreasonably restrain trade, and might well be relevant in such action as the formation of any joint ventures or teaming arrangements. [57] On the other hand, some laws of a general nature may be considered favorable to such potential operations, for example, some of the tax laws are considered for such activities as research and development expenditures and venture capital investments in new technology-based firms. [58]

PRIVATE INDUSTRY PERCEPTIONS

In the light of the previously discussed international situation and domestic regulatory framework, it would seem that private industry might make certain arguments to help establish a posture that too many obstacles or unknowns exist to encourage the commercial risk and expense in most instances by private undertaking.

[54] 47 U.S.C. §701 (d)
[55] 48 Fed. Reg. 8460, 8462, March 1, 1983.
[56] 15 U.S.C. §1 et seq.
[57] See, Donald L. Flexner, *The Impact of Antitrust on Commercial Ventures to Exploit Space Technology*, in ALI-ABA Conference Materials, *International Conference on Doing Business in Space: Legal Issues and Practical Problems* (1981), at 305.
[58] See, Report of the National Academy of Public Administration, *Encouraging Business Ventures in Space Technologies* (May 1983), at 35–36.

1. Not only are a number of international law issues concerning space and space activities controversial and unsettled, private rights would be subject to negotiation or even extinguishment under current or future international negotiation pressures.

2. Present U.S. statutory provisions emphasize public (NASA) participation in most space activities or rights thereto, and leave little encouragement or incentive for viable private action.

3. An administrative morass exists concerning private launchings of rockets making it extremely difficult and burdensome to effectuate the necessary clearances in a timely and practical fashion.

4. The establishment by the Congress of a quasi-private entity with certain inherent competitive advantages, including initial access to certain participation and information, presents certain possible commercial impediments to others.

What does private industry want? As a legal optimum, private industry possibly might contend that there should be an express national space policy which includes specific roles, goals or objectives for private commercial ventures, with the minimum amount of Government regulation. Other desires might include Government financial incentives, including such items as direct subsidies, loan guarantees, tax breaks, and limits on liability. If there is to be some Federal agency oversight, it should preferably be by only one. If multiple agencies need be involved, there at least should be one lead agency for industry to deal with and which would be responsive to it. Exemptions from certain general regulatory laws, such as the antitrust laws, should be provided. Proprietary commercial rights should be retained for and by private actions and inventions. Government insurance should be available in the event that private insurers fail or refuse to provide adequate coverage for the risks involved. The Government should provide protection by way of a grandfather clause if future international agreements are negotiated affecting existing private U.S. rights. [59]

Some Recent Legislative Proposals

While a series of earlier proposals in Congress seemed primarily involved with providing investment capital and establishing the necessary business conditions to attract industries to use the space environment to manufacture products and provide services through the creation of a Space Industrialization Corporation to serve as an investment bank, [60] so far in the 98th Congress [as of May 3, 1983] proposals generally seem to involve three tacts, sometimes treated separately or in tandem. The legislation introduced so far that seems to be the broadest in scope is H.R. 1011 (98th Cong.), the "Space Commerce Act." Its stated findings and purpose are:

FINDINGS AND PURPOSE

SEC. 2. (a) FINDINGS.—The Congress finds and declares that—

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[59] Precedents in a number of these areas with regard to other areas of technology are pointed out in Office of Technology Assessment, *Civilian Space Policy and Applications*, OTA-STI-177, June 1982, at 268-270.

[60] E.g., H.R. 564, 97th Cong.; H.R. 2337, 96th Cong.; and H.R. 14297, 95th Cong. Also, see, Fuqua, *Space Industrialization: Some Legal and Policy Considerations for Private Enterprise*, 8J. Space L. 1 (1980)

(1) the peaceful use of outer space continue to be of great value and to offer benefits to all mankind;

(2) civilian applications of space technology have achieved a significant level of commercial and economic activity, and offer the potential for growth in the future, particularly in the United States;

(3) new and innovative equipment and services are being sought, created, and offered by entreprenuers in telecommunications, information services, and remote sensing technology;

(4) the private sector in the United States has the capability of developing and providing private satellite launching and associated services that would supplement the launching and associated services now available from the United States Government;

(5) cost savings could accrue from the private sector developing and providing launching services;

(6) the development of such services would enable the United States to better compete with the launching services now being developed by foreign countries, thereby contributing to the national interest and economic well- being of the United States;

(7) commercial provision of such services is not inconsistent with the national security interests of the United States;

(8) the United States should encourage and, to the extent reasonable necessary, regulate private sector launching and associated services to provide for the national security and public safety and to carry out the obligations of the United States under international treaties affecting the use of space;

(b) PURPOSE.—It is the purpose of this Act to—

(1) encourage the development of the United States private sector of capabilities for providing launching and associated services;

(2) provide the necessary regulation by the Federal Government to ensure public safety and national security and to carry out obligations of the United States, such as liability for damage from space objects, under applicable international treaties and agreements affecting the use of space;

(3) stimulate private sector applications of Government-developed space technology; and

(4) promote further economic growth and entreprenuerial activity in utilizing the space environment for peaceful activities.

A detailed licensing procedure for a private launching is set forth, and the Secretary of Commerce would be responsible for carrying out the act and providing a designated point of contact within that Department for the licensing procedure as well as to coordinate and facilitate all Federal actions pertinent to private sector launches. The obtaining of liability insurance is a prerequisite for such launchings. The act also would establish a Commercial Space Study Commission to "conduct a study of the direction of future Government involvement in, support of, and regulation of private sector commercial activity in outer space." A similarly motivated bill has been introduced in the Senate, S. 560, the "Private Satellite Launching Authorization Act of 1983," with similar findings, purpose, and policy. It, however, would make the Administrator of the FAA in charge of a licensing procedure (not set forth in the proposal), and also to promulgate regulations concerning safety standards for the design and construction of space launch vehicles and for their launching, as well as liability insurance requirements. A separate bill, S. 955, the "National Commission on Space Act" would establish a National Commission on Space (and covers this aspect in greater detail than H.R. 1011), whose functions, in part, would include:

FUNCTIONS OF THE COMMISSION

SEC. 6. (a) The Commission shall make a comprehensive investigation of exisiting and proposed space activities in the United States in order to assess their adequacy in meeting the present and future needs of the Nation. Such study shall include--

(1) a review of the known and possible economic, social, environmental, foreign policy, and national security needs of the United States, and methods by which space science, technology, and applications initiatives might address those needs;

(2) a review of the adequacy of the Nation's public and private capability in space science, technology, and applications;

(3) a review and assessment of present issues and issues that may arise as space research, technology development, and applications are utilized to meet future national needs; and

(4) an analysis of the findings of the reviews specified in paragraphs (1) through (3) of this subsection, and options and recommendations for a national space policy and program plan.

(b) Issues to be considered pursuant to subsection (a)(3) of this section shall include—

(1) the adequacy of the National Aeronautics and Space Act of 1958 (42 U.S.C. 2451 et seq.) to serve as the basis for future national space policy;

(2) alternative roles and relationships of the civilian and national security space programs;

(3) alternative roles and relationships of the private and public sectors in national space efforts.

(4) the suitability of existing Federal organizational arrangements to carry out future governmental responsibilities in space research, technology development, and applications;

(5) the opportunities for, and barriers to, private sector utilization of the space environment and participation in national space programs;

(6) the methods, occasions, and circumstances under which the Nation should pursue a permanent presence in space; and

(7) considerations involving international cooperation and competition in the utilization of the space environment.

(c) Options and recommendations submitted in accordance with subsection (a)(4) of this section shall include an estimate of costs and time schedules, institutional requirements, and statutory modifications necessary for implementation of such options and recommendations.

Another tact can be found in H.R. 478 (98th Cong.), the "National Space Policy of 1983" (with 64 cosponsors), which is designed to establish the national space policy of the United States. Two of the stated findings are:

(10) the successful development and use of the space environment for scientific and applied purposes depends on continued research and development efforts conducted by the government and private sector; and

(11) the productive development and use of the space environment requires new policies, procedures, and institutional arrangements that encourage initiative by, and use the innovative capabilities of, the private sector.

Two of the declared statements of policy are:

(9) the benefits of space program research to terrestial applications will be maximized by rapid dissemination of information concerning such programs to appropriate public and private bodies; and

(10) the development of space capabilities and systems by the private sector to produce economic benefits to, and to enhance the technological position of, the United States, will be encouraged.

In addition, a number of bills have been introduced which provide, in effect, that the ownership or management of any civil land remote system or meteorological satellite system, or their associated ground systems, cannot be transferred to the private sector

without the approval of the Congress.[61] On April 26, 1983, the House of Representatives passed the NASA authorization bill, H.R. 2065 (98th Cong), to which just such a provision had been added.

Some Possible Future Legal Problems

Private sector involvement in space activities will probably prompt numerous legal problems, particularly as the space technology advances and more human activity takes place in outer space.

CLAIMS

A number of areas may be involved with potential damage to property or injury to persons.

Safety

A regulatory safety regime may be necessary, covering vehicle safety and space worthiness, competency of crews, and design of systems to insure maximum safety of flights and return.[62] The possibility of health emergencies may arise, including Earth quarantines.[63]

Liability

Potential high-technology catastrophic accidents could pose problems. Except for nuclear accidents, NASA's coverage for users of the Space Shuttle and some relatively minor statutes, there is no comprehensive statute dealing with manmade accidents.[64] Responsibilities, obligations, funding, contributions, and claim procedures are the kinds of matters that may need clarification. Other potential claims for liability might arise, such as products liability,[65] which may require resolution mechanisms.

Insurance

Space activity involves new risks, without customary, Earth-oriented perils.[66] Present law covering and permitting NASA to allocate third-party liability risks among the users of the Space Shuttle[67] may not be a viable precedent in other areas, and creative insurance and re-insurance schemes may be called for.[68] At some point, Government participation and/or oversight may be necessary.

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[61] See, e.g., H.R. 1958, H.R. 2507, S. 480 (98th Cong.)

[62] Stewart, Jr., *Emerging Patterns of a Private International Space Law Regime—Evolutionary or Revolutionary?* IISL, *Proceedings of the Twenty-Third Colloquium on the Law of Outer Space* (1980), at 201, 202.

[63] Robinson, *Earth Exposure to Martian Matter: Back Contamination Procedures and International Quarantine Regulations*, 15 Colum. J. Transnat'l L. 17 (1976). Present regulations, 14 CFR, Part 1211, are limited in scope and only apply to NASA missions that come in contact with the atmosphere of celestial bodies.

[64] Dembling, *On Doing Business in Space*, 20 Astronautics & Aeronautics 18, 176 (1982).

[65] See, Haanappel, *Products Liability in Space Law*, 2 Hous. J. Int'l l. 55 (1979)

[66] Banham, *Count-Up for Space Insurance*, the Journal of Space Insurance, January/February (1982)

[67] 42 U.S.C. § 2458 (b).

[68] Mossinghoff, *Managing Tort Liability in the Era of the Space Shuttle*, 7 J. Space L. 121, 126 (1979). Also, see, Margo, *Some Aspects of Insuring Satellites*, 1979 Ins L.J. 555 (1979)

JURISDICTION

A great number of problems that are jurisdictional in nature may arise as more diverse commercial activities increase in space and larger numbers of persons spend greater time in that environment. As ownership, financing and participation becomes more multinational, that is, employing more and more citizens or business entities from different nations, as well as proprietary or registered bases in more than one nation or involving international organizations, it may become more difficult to ascertain what laws apply to diverse actions and even who is to make that kind of determination. For example, as satellite ownership becomes increasingly fragmented, "it becomes correspondingly difficult to associate particular treaty and statutory obligations (for example, coordination, tariffs, permissible business practices) with specific entities." [69] Not only may a conflict of law issue arise in any given instance, but questions as to the extraterritorial application of U.S. laws and even the U.S. Constitution may become issues. Certain assertions may even be made under international law. "If all persons in outer space—not merely astronauts and cosmonauts—are assimilated to the status of envoys of mankind and are the subject of international law, some inevitable collisions are perceived between the control of persons in space by the state of nationality and the individual assertion by such persons of internationally recognized human rights and fundamental freedoms." [70]

All sorts of possibilities may exist if analogies are made. Will there be the same sort of "genuine link," salvage, and search and seizure problems that now exist in maritime situations on the high seas? Will specific criminal offense treaties be necessary as has been prompted by crimes committed aboard aircraft?

CONCLUSION

Any ambitious scheme to promote private sector involvement in commercial activities in outer space presents a number of legal problems on several levels. The present regulatory scheme, both international and domestic, for the most part is operationally designed for national interest and responsibility. Any shift of such emphasis to a cross section of private control raises a potential realignment of rights and obligations between the United States and the international community, between the United States and such private sector entities, and between those entities themselves. Legal considerations are crucial on each strata. Adding to the legal complexity is the nature of the activity itself as well as the rapidly evolving technology involved. Great expenditures may be necessary, and high and unforeseen risks may enter the picture. Operational areas are not limited to the territorial confines of the United States, and the potential for calamitous consequences exists.

To facilitate action, among other things it may be necessary to: pinpoint the kinds and extent of commercial involvement that may

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[69] Smith and Rothblatt, *Geostationary Platforms: Legal Estates in Space*, 10 J. Space L. 31, 35 (1980)

[70] Glazer, *Domicile and Industry in Outer Space*, 17 Colum. J. Transnat'l L. 17 (1976).

be practicall·· and politically possible; describe with great detail the form and content of any Government regulation, including a systematic approach as to who, what, when and where private action may be taken; and undertake a close examination as what new international controls may be prudent. Once significant private involvement is forthcoming, any developing legal framework will likely be ongoing. Novel legal problems will probably arise, calling perhaps for new and creative legal theories and enforcement mechanisms.

APPENDIX—SUMMARY OF SPACE COMMERCIALIZATION PROPOSALS

The number of commercial space proposals in areas ranging from expendable launch vehicles to space stations grows almost weekly. The following is a summary of those proposals which could be identified through April 30, 1983. Some are only in the conceptual stage, others are already operational.

In brief, the companies making proposals, according to commercial area, are as follows:

Expendable launch vehicles
- ARC Technologies (Dolphin)
- General Dynamics (Atlas-Centaur)
- Satellite Propulsion, Inc. (Liberty)
- SpaceTran/Martin Marietta (Titan 34D)
- Space Services, Inc. (Delta, Conestoga)
- Transpace Carriers Inc. (Delta)

Reusable space vehicles
- Pacific American Launch Systems (Phoenix)
- Transpace Inc. (Space Van)

Upper stages
- McDonnell Douglas (Payload Assist Module—PAM)
- Orbital Systems Corp. (Transfer Orbit Stage—TOS)

In-Orbit facilities/equipment
- Architects Equities, Inc. (Shuttle payload bay materials processing)
- Ball Aerospace (Shuttle payload bay materials processing)
- Fairchild (Leasecraft, free-flying module for power, telemetry, control, etc.)
- GTI (materials processing furnace—Agreement with NASA terminated)
- Space Industries (space station)

Materials processing experiments
- Battelle Columbus Laboratories
- Beckman Instruments
- Dupont
- EG&G
- Eli Lilly
- Honeywell
- Inco
- John Deere
- Johnson and Johnson/McDonnell Douglas
- Johnson Matthey
- Microgravity Research Associates
- Northrop
- Parker-Hannifan Corp.
- Robert Shaw Associates

A. E. Staley Manufacturing
Terra Mar
TRW
Union Carbide

Space Shuttle

Astrotech International (payload processing facilities at Kennedy Space Center)
Hughes Aircraft (satellite manufacturing and possible payload processing at KSC)
SpaceTran (purchase of a fifth orbiter)

Remote sensing satellite systems

Several companies have indicated interest in operating the existing Landsat system (space and/or ground segments) and possibly the NOAA weather satellites, but no formal proposals have been made at this time. In addition, one company, American Science and Technology, has proposed developing and launching its own remote sensing satellites although its proposal is not formal yet, either.

Existing NASA Mechanisms for Encouraging Commercial Space Activities

There are currently three types of agreements which NASA uses in facilitating Government/industry cooperation in commercial space endeavors: A cooperative agreement, a joint endeavor agreement, and a technical exchange agreement. [1] The differences between the three are slight, and which one is used for a particular activity depends primarily upon which NASA office is in charge of the agreement. For example, the joint endeavor and technical exchange agreements are used primarily for materials processing experiments—the former most often when an actual flight experiment is contemplated, the latter when experimentation primarily takes place on the ground. The term "cooperative agreement" was initially coined as part of NASA s international activities and denoted an agreement between NASA and another country in which no exchange of funds occurred. Its meaning has now been extended to commercialization activities between NASA and the private sector, such as the agreement with Orbital Systems Corp. for development of an upper stage.

Expendable Launch Vehicles/Upper Stages

There are currently four expendable launch vehicles (ELV's) in use in the United States: Titan, used primarily by the DOD and manufactured by Martin Marietta; Delta, used primarily by NASA and manufactured by McDonnell Douglas; Atlas, used by both NASA and DOD and manufactured by General Dynamics; and Scout, used primarily by NASA for very small payloads, and manufactured by LTV Aerospace. Proposals to commercialize the first three of these systems have already been made public. Martin Marietta, in conjunction with SpaceTran Inc., is actively marketing its Titan 34D vehicle, while General Dynamics is similarly marketing

[1] Information for this section is based on a meeting and subsequent telephone conversations with a NASA representative, April 1983.

its Atlas-Centaur. McDonnell Douglas has no plans at this time to market the Delta, although two other companies, Transpace Carriers Inc. and Space Services. Inc. have shown interest in this ELV. Both companies are holding discussions with McDonnell Douglas concerning their proposals, but no definitive arrangements have been made.

Three companies are in the process of developing their own ELV's: Space Services, Inc. is developing the Conestoga rocket based on Minuteman technology and has successfully completed one suborbital test flight; ARC Technologies of Redwood City, Calif. is developing the Dolphin which will be launched from the ocean rather than land, and is initially being developed as a suborbital sounding rocket; and Satellite Propulsion, Inc. of Beverly Hills, Calif. is considering development of an ELV called Liberty to compete with Atlas-Centaur.

There are also several upper stages used with the ELV's and/or with the Shuttle: the Payload Assist Module (PAM), developed and manufactured by McDonnell Douglas; the Inertial Upper Stage (IUS), developed under Government contract and manufactured by Boeing; Centaur, developed under Government contract and manufactured by General Dynamics with a new version for use with the Shuttle now in development; and the Transfer Orbit Stage (TOS) being developed privately by Orbital Systems Corp. under a cooperative agreement with NASA.

The following tables summarize the characteristics of the ELV's and upper stages that are being proposed for commercialization.

U.S. Expendable Launch Vehicles Proposed for Commercial Operations

Vehicle [1]	Manufacturer	Entity planning to commercialize	Fuel type	Payload weight to orbit, [2] comments
Dolphin	ARC Technologies	ARC Technologies	Hybrid	Suborbital; 500–2,000 lbs to 100–300 miles altitude. Vehicle being privately developed; may have orbital version later.
Liberty	Satellite Propulsion Inc.	Satellite Propulsion Inc.	Liquid	6,300 lbs to LEO (due east) 4,500 lbs to GTO. Vehicle being privately developed.
Atlas-Centaur	General Dynamics	General Dynamics	Cryogenic	5,200 lbs to GTO in 1983; improvements to 14,000 lbs to GTO planned. Developed under Government contract.
Conestoga	Space Services, Inc.	Space Services, Inc.	Solid	500 lbs to LEO (polar orbit). Vehicle being privately developed.
Delta 3910/3920 (with PAM)	McDonnell Douglas	TranSpace Carriers; Space Services, Inc.	Liquid	5,500 lbs to LEO. Delta 3910 can put 2,450 lbs in GTO; Delta 3920 can put 2,800 lbs in GTO. Vehicle developed under Government contract.

U.S. Expendable Launch Vehicles Proposed for Commercial Operations–Continued

Vehicle [1]	Manufacturer	Entity planning to commercialize	Fuel type	Payload weight to orbit, [2] comments
Titan 34D	Martin Marietta	SpaceTran/Martin Marietta	Liquid	31,000 lbs to LEO. Can put 5,600–6,000 lbs in GEO assuming satellite has own kick stage. Vehicle developed under Government contract.

[1] Launch vehicles typically have several different versions each with different capabilities. The version(s) listed here are those specifically for which commercialization proposals have been made.

[2] LEO is low Earth orbit. GEO is geostationary Earth orbit. GTO is geostationary transfer orbit, an eccentric orbit into which a payload is initially placed, after which an additional kick stage is used to circularize the orbit at GEO. Approximately half the payload weight to GTO is taken to GEO. All payload weights are in pounds (lbs).

Source: All data were obtained from the companies involved in manufacturing or commercializing the vehicle, or NASA.

U.S. Upper Stages

Vehicle	Manufacturer	Used in conjunction with	Fuel type	Payload to GEO	Comments
Centaur	General Dynamics	Shuttle [2]	Cryogenic	10,600 lbs. [2]	In development under Government contract. [2]
IUS	Boeing	Shuttle or Titan	Solid	5,000 lbs	In use, but failed its second launch in March 1983. Developed under Government contract.
PAM D	McDonnell Douglas	Shuttle or Delta	Solid	2,750 lbs. [1]	In Use.
PAM D II	McDonnell Douglas	Shuttle or Delta	Solid	3,500–3,900 lbs. [1]	In Development.
PAM A	McDonnell Douglas	Shuttle or Delta	Solid	4,400 lbs. [1]	Developed privately by McDonnell Douglas.
TOS	Orbital Systems Corp.	Shuttle	Solid	2,800–6,800 lbs.	In development. Being developed privatly by OSC.

[1] Indicates payload weight is to geostationary transfer orbit, not geostationary orbit (GEO).

[2] Centaur can also be used with Atlas and Titan, but the version here is the one in development for use with the Shuttle. The company also plans to develop a version with a 14,000 lb capability for planetary missions. Centaur can have a greater payload capability with improvements in Shuttle system.

Source: All data were obtained from the manufacturers or NASA.

Reusable Space Launch Systems

Two concepts for reusable space launch systems which could be used in either a manned or unmanned mode are also being promoted. Both are still in the conceptual stage, and the sponsors have not yet found financing.

The first is called Space Van and is being offered by a company called Transpace Inc. (not to be confused with Transpace Carriers Inc. which is proposing to commercialize the Delta), headed by Len Cormier of Washington, D.C. [2] Space Van could be used in an unmanned "cargo" mode or a manned "orbiter" mode. In the former

[2] The Amazing Private Mini-Shuttle. Science Digest, August 1982, pp. 80–81. Proposed Space Van Wants to Challenge Shuttle for Small Payloads. Satellite Week, October 19, 1981, p. 5. Information also obtained directly from Transpace Inc.

type of mission, the vehicle would operate as a reusable booster with an expendable space stage. In the latter, it would be similar to the Space Shuttle. In both cases, it would be launched from a 747 aircraft, and use Pratt & Whitney RL-10 cryogenic engines. In the cargo mode, a payload of 6,600 pounds could be placed into a 280 mile orbit. Payloads of 1,760 pounds could be placed in geosynchronous orbit, unless low-orbit refueling was used, in which case 6,600 pounds could be placed there. According to its promoters, it might reduce costs to one-fifth that of the Shuttle.

The second concept is for a reusable manned or unmanned launch vehicle called Phoenix. Promoted by Pacific American Launch Systems, Inc., Phoenix would be very versatile according to its creator, Gary Hudson of Redwood City, Calif., and could be used for missions to low Earth orbit, geosynchronous orbit, or even to the Moon. [3] Phoenix would be a single stage vehicle using high efficiency, liquid fueled engines (liquid oxygen, hydrogen, and propane) and would be able to place 5,000-10,000 pounds into GEO without requiring an upper stage. According to Hudson, the Phoenix will be considerably less expensive than the Space Shuttle to launch ($50 million for use of an entire Phoenix vehicle in 1986, compared to an expected $70 million for an entire Space Shuttle flight—actual prices for use of either will depend on the size and weight of the payload).

In-Orbit Space Facilities

Several companies have set forth plans for developing space facilities as cooperative efforts with NASA.

Fairchild Industries of Germantown, Md. signed a memorandum of understanding (MOU) with NASA in September 1982 initiating discussion for the proposed development of a mini space platform called Leasecraft. [4] The facility could be left in space for indefinite periods of time (the Shuttle is currently designed for orbital stay times of two weeks or less), and be tended by the Shuttle on subsequent missions. Leasecraft would provide power, stabilization, communications, and orbital adjustment capabilities for various payloads, and would be based on the Multimission Modular Spacecraft designed for NASA by Fairchild and used already for the Solar Maximum Mission and Landsat 4. Under the MOU, NASA and Fairchild will study Leasecraft with the goal of having it available in orbit by 1986. Fairchild would be responsible for leasing space to government and industry users. Among the payloads expected to require such a facility are materials processing and biological processing plants, and astronomical observatories. NASA would launch Leasecraft for Fairchild in exchange for free use of the platform for certain periods.

A second proposal is by a Houston based company, Space Industries. One of the founders of the company is retired NASA spacecraft designer Maxime Faget who was instrumental in designing

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[3] Percheron Designer Works Toward Launcher for LEO, GEO, and Moon. Aerospace Daily, Feb. 18, 1983, pp. 283-84. Pacific American Launch Systems Unveils New Rocket Design. Satellite Week, February 21, 1983, pp. 4-5.

[4] Potential of Mini Space Platform to be Studied. NASA Press Release 82-141, September 28, 1982.

both Apollo and Space Shuttle. Space Industries signed an MOU with NASA in late 1982 to study the private development of portions of a space station.

Architects Equities Inc. (Champaign, Ill.), has proposed a computer-aided space factory to be operated in the Shuttle by remote control from the ground or with preprogramed robots. The proposal was in response to NASA's request for proposals on space station studies, but did not meet the criteria for actually submitting a bid since it did not meet all mission requirements and the company is not adequately staffed. NASA is reportedly interested in the idea, however. [5]

Ball Aerospace Systems is considering the construction of a facility in which to carry payloads in the Shuttle cargo bay, and signed a memorandum of understanding with NASA in September 1982 to work on development of a joint endeavor agreement. [6]

In 1982, NASA signed a joint endeavor agreement with GTI Corp. for development of a furnace for metallurgical research which would have been mounted in the Shuttle payload bay. After 1 year and an expenditure of approximately $600,000 of its own money, GTI terminated the joint endeavor agreement in the spring of 1983 because it saw no market for the device at this time, and because NASA had not developed the carrier device needed to mount the furnace in the payload bay (construction of the furnace could not proceed without knowledge of that interface). [7]

Materials Processing in Space

Among the areas in which NASA expects substantial commercial activity in the next several years is materials processing in space (MPS). This field includes processes which benefit from the lack of gravity in space, such as electrophoresis (in which biological products are separated from their solution by passing an electric current through the fluid), the growth of more perfect crystals (for use in electronic chips, for example), and the creation of new metal alloys.

NASA experimented with MPS during the Apollo and Skylab programs, although the total amount of time spent on such activities during those programs was only about 8 hours. NASA's joint endeavor program is one method for assisting private industry to perform MPS experiments. Only three joint endeavor agreements have been signed for MPS, however, and one of these has subsequently been terminated. The first, with McDonnell Douglas and Ortho Pharmaceuticals (a division of Johnson and Johnson), concerns electrophoresis, and an experimental device has been flown on two of the six Shuttle missions to date. Three more flights are planned in the series, after which McDonnell Douglas/Ortho may proceed to space factory production. The second joint endeavor was the one with GTI for an MPS furnace discussed previously, while the third is with Microgravity Research Associates, signed in April

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[5] Aerospace Daily, August 17, 1982: 263.

[6] Telephone conversation with Ball Aerospace representative, April 1983.

[7] Joint Agreement Signed for Materials Processing Device on Shuttle. NASA Press Release 82-10. January 28, 1982. NASA and GTI Conclude Joint Endeavor Agreement. NASA Press Release 83-23. February 24, 1983. Lack Of MPS Market Hits Shuttle Furnace Agreement. Aerospace Daily, January 27, 1983, pp. 149-150.

1983, for development of a process for making semiconductor materials.

In addition to the joint endeavor agreements, NASA has also signed a technical exchange agreement with John Deere and Co. to study the effects of microgravity on iron alloys. The agreement, signed between NASA's Marshall Space Flight Center and Deere in July 1981, provides for Deere to use NASA's low-gravity facilities (such as drop tubes and sounding rockets) to conduct research which might lead to future experiments aboard the Space Shuttle. Data is exchanged between the two parties in return for Deere's access to the NASA facilities. Technical exchange agreements have also been signed with Honeywell, Inco, and Dupont,

Other companies reportedly pursuing work related to MPS include: Battelle Columbus Labs, Union Carbide, TRW, A.E. Staley Manufacturing, Beckman Instruments, EG&G, Robert Shaw Associates, Northrop, Terra Mar, Parker-Hannifin Corp., Eli Lilly, and Johnson Matthey, Inc. [8]

Space Shuttle

Several proposals have been made in connection with commercial opportunities associated with the Shuttle. Two of these involve private companies building payload processing facilities near Kennedy Space Center (KSC). NASA is currently in charge of payload processing, but its facilities are overworked. In 1983, Astrotech International announced plans to build a payload processing facility near KSC, and through an exchange of letters made arrangements with NASA to ensure that payloads processed there would meet NASA standards. Hughes Aircraft is also actively considering a payload processing facility near KSC in conjunction with a satellite assembly plant there.

A different type of Shuttle-related proposal was received by NASA in 1982 from SpaceTran Inc., a Princeton, N.J. based firm. SpaceTran offered to purchase a fifth Shuttle orbiter for NASA in exchange for exclusive marketing rights to commercial and foreign users of the Shuttle system. The proposal is undergoing negotiation at the present time and details of changes that have been requested by NASA have not been made public. SpaceTran, which is partially owned by Prudential Insurance Co., is currently in a transition phase following the purchase of 20 percent of the company by Federal Express in early 1983.

Remote Sensing

As noted earlier, no formal proposals have been made for commercializing the civil land and weather remote sensing satellite programs, although the Reagan administration announced plans for such a transfer of operations to the private sector in March 1983.

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[8] These companies have been identified in the following manner: Battelle—telephone conversation with company representative, April 1983; Union Carbide—Aerospace Daily, January 6, 1983, p. 30; TRW, Staley, Beckman, EG&G, Robert Shaw Assoc., Northup, Terra Mar, and Parker-Hannifan—identified by Robert Sharples of TRW as participants in a TRW-sponsored workshop in October 1982 for companies pursuing MPS work in a telephone conversation, April 1983; Eli Lilly and John Matthey—Aerospace Daily, April 22, 1983, p. 309.

In 1982, NOAA, which currently operates these systems, issued a request for information to companies interested in potential operation of the systems and several companies responded. Only one, Comsat, presented a plan for operating both the space and ground segments of the land and weather satellite systems. Comsat's response included possible terms that it might make in a formal proposal to the Government, which included purchase of the existing system for $250–$350 million, plus a guaranteed Government data purchase of approximately $300 million per year for 15 years. Other companies (including Hughes, RCA, General Electric, Control Data Corp.) indicated interest in parts of the Landsat ground segment, but not the satellites themselves.

One company, American Science and Technology (AS&T), has proposed constructing its own remote sensing satellites for launch using the Conestoga launch vehicle. Space Services, Inc., developers of the Conestoga, is a majority stockholder in AS&T.

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